The Effects of Lean Six Sigma Critical Success Factors on Organizational Performance: A mixed-methods study on United Arab Emirates Hospitals

Volume 1 of 2

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Submitted for the degree of Doctor of Philosophy

Heriot-Watt University

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November 2019

ABSTRACT

Healthcare is an industry where mistakes are not tolerated. Various Improvement methodologies such as Total Quality Management (TQM), Lean and Six Sigma intend to improve the performance of processes and impact organisational performance. Lean Six Sigma (LSS) combines approaches for flow and quality with the intent to reduce waste, variation and defects in processes. There have been many attempts to implement LSS. However, there is a lack of academic research on the extent of implementation or whether it leads to improvement. Generic lists of Critical Success Factors (CSFs) have been created, but they have not yet been explored in more dynamic settings such as healthcare in developing countries. The purpose of this study was to examine LSS implementation in UAE hospitals being a multi-cultured, professional and high labour turnover environment. The study also examined whether Strategic, Tactical and Operational (STO) CSFs are positively correlated with LSS successful implementation measured by hospital performance.

A mixed-method approach was adopted to explore the study aim and objectives also enhancing the study quality in terms of reliability and validity. A conceptual model was developed from a review of the literature and existing improvement frameworks identifying three distinct CSFs themes (Strategic, Tactical and Operational) and eight hospital performance indicators. The study analysed the findings from a survey, interviews and a brainstorming session using SPSS, thematic analysis, Partial Least Squares Structural Equation Modelling (PLS-SEM) and Interpretive Structural Modelling (ISM). The study revealed that CSFs in healthcare should be sequenced in clusters, therefore creating a new framework for deploying LSS. Workforce stability and job security emerged as two new CSFs. Moreover, the empirical results showed that LSS CSFs have a positive effect on the performance of the UAE hospitals confirming previous research in other sectors. While the results confirmed that the UAE healthcare sector shares many common LSS CSFs and barriers identified in previous research, the study revealed three new barriers, namely lack of sustainability of LSS, lack of a holistic approach to deploy LSS and lack of advertising LSS success stories. This study contributes to academics and practitioners by providing a deployment framework for LSS in healthcare, offering better insights on the current status of LSS in UAE healthcare to enhance LSS deployment towards better organisational performance.

‘The only true wisdom is in knowing you know nothing.’ **Socrates**

DEDICATION

This work and study are dedicated to:

My Mother

Who illuminates my life and provides support and encouragement throughout my life

My late Father

Who never ceased to encourage me and has been my hero

My wife, Ziena

My guiding compass and anchor whom without her support, this work will never have seen the light

My children, Taline and Atef

For their unrelenting support and love. I hope this work will inspire them to light their candles towards their own contribution to global knowledge

ACKNOWLEDGEMENTS

First, thanks and praise to Allah, the most Gracious and most Merciful for giving me the support and strength to complete this humble work in an effort to enrich the knowledge of organisational quality and improvement.

I am deeply grateful to my principal supervisor Dr Lynne Baxter, from the University of York, for her valuable guidance, critical advice and constant support throughout this journey. Thanks are also due to Professor Steve Carter and Dr Patrick O'Farrell from Edinburgh Business School (EBS) for their guidance through the development of the proposal, mentoring and supervision process. I would also like to express my gratitude to my external examiner, Professor Maneesh Kumar, from Cardiff University, and my internal examiner, Professor Umit Bititci for their valuable comments. It was an honour and a pleasure to work with them.

My thanks go to friends, colleagues, family members and all the people who have supported me directly or indirectly. For your continuous support and encouragement, I thank you. I also wish to acknowledge the support of my sponsor, Meirc Training and Consulting, for offering me the opportunity to ‘sharpen my saw’ and contribute to global knowledge. I would also like to acknowledge my colleagues, Dr Ramsey Hakim, Samer Taher and Chaouki Eid for their constant support and encouragement.

Last but not least, words can’t express my thanks, gratitude and love enough to my soul-mate, Ziena, for her continuous support and understanding during the past challenging years.

I wish to gift this humble achievement to my beloved father, Dr Atef Bawab, who passed away in November 2017, who always encouraged me to obtain my doctorate. God bless his soul.

Fawzi Bawab

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LIST OF ABBREVIATIONS AND GLOSSARY

ABBREVIATION	MEANING
ASQ	American Society for Quality. One of the well-known non-profit organisations that focus on developing quality worldwide
ANOVA	Analysis of Variance. A statistical test for identifying significant differences between process or system treatments or conditions.
BB	Black belt. A person who receives four weeks training in DMAIC, analytical problem solving and change management methods
BSC	Balanced Scorecard
CB-SEM	Covariance-based– Structural Equation Modelling. One of the techniques used in regression analysis
CSFS	Critical success factors.
DFSS	Design for Six Sigma. The use of Lean Six Sigma thinking, tools and methods applied to the design of products and services to improve the initial release performance, ongoing reliability, and life-cycle cost.
DMAIC	The core phases (Define, Measure, Analyze, Improve and Control) of the Lean Six Sigma methodology used to solve process and business problems through data and analytical methods.
DOE	Design of Experiments
DPMO	Defects per Million Opportunities. The total number of defects observed divided by the total number of opportunities, expressed in parts per million A Measure used in Six Sigma to predict and measure defects in processes.
EFQM	European Foundation For Quality Management
GB	Greenbelt. A person who receives approximately two weeks of training in DMAIC, analytical problem solving and change management methods
GCC	Gulf Cooperation Council.
ISM	Interpretive Structural Modelling
JIT	Just in Time

LSS	Lean Six Sigma
JCIA	Joint Commission International Accreditation
MBNAQ	Malcolm Baldrige National Quality Award
LSSMBB	Lean Six Sigma Master Black Belt. A person who has received training beyond a Black Belt. The technical, go-to expert regarding technical and project issues in Lean Six Sigma
MLR	Multiple Linear Regression
PLS-SEM	Partial Least Squares – Structural Equation Modelling
SPC	Statistical process control
TPS	Toyota production system
TQM	Total quality management. A management approach that focuses on the organization as a system, with an emphasis on teams, processes, statistics, continuous improvement, and delivering products and services that meet and exceed customer expectations.
UAE	United Arab Emirates
VSM	Value Stream Mapping. One of the techniques used under Lean to map the process and identify waste/ opportunities to speed up the process.

Source: (Brue 2002; Brighthub 2017; Opensource 2017)

PUBLICATIONS

Bawab, F. & Baxter, L., 2018. The Relationships between Lean Six Sigma Strategic, Operational and Tactical factors and organisational performance in hospitals: A proposed model. In *Seventh International Conference on Lean Six Sigma*. Dubai-UAE, pp. 38–47.

CHAPTER 1: INTRODUCTION AND RESEARCH OVERVIEW

1.1 Background of the study

It is imperative for organisations belonging to different industries to perform well within their domain. Due to the constant changes in the market and demands of the customers, various organisations test various quality initiatives to improve their processes' performance, reduce cost and enhance customer satisfaction. Six Sigma has become one of these popular initiatives used by various organisations to enhance their performance (Sony et al. 2018; Antony and Kumar 2012). Six Sigma, a trademark of Motorola that started in the US in the early 1980s, is a business process methodology, derived from TQM principles, incorporates the teachings of various quality professionals such as Deming, Juran and Feigenbaum (Deming 2000; Pande et al. 2000; Juran et al. 1999; Feigenbaum 1956). Six Sigma can be defined as follows:

> *'Six Sigma is a well-established approach that seeks to identify and eliminate defects, mistakes or failures in business processes or systems by focusing on those process performance characteristics that are of critical importance to customers.'*(Antony et al. 2005, p.860).

In addition to Six Sigma, Lean practices are also employed by different organisations to improve the overall value of a process stream. Lean was developed by Toyota and labelled as the Toyota production system (TPS) (Womack et al. 1990; de Souza and Pidd 2011; Arthur 2011). The term 'Lean Manufacturing' was used by John Krafcik in the book *The Machine that Changed the World* (Womack et al. 1990). It has been posited that Six Sigma combined with Lean, can lead to an effective and insightful approach that would result in improved processes in various sectors (Sinclair et al. 2005; Salah et al. 2010). The integration of Lean and Six Sigma is referred to as Lean Six Sigma (LSS) (George 2002) and has become of interest to many researchers.

1.2 Research problem and UAE context

The global healthcare sector is one of the most growing sectors in the world with more than US$7,682 million in expenditure in 2015, pressuring healthcare operations to reduce cost while aiming to enhance patient safety and satisfaction (INSEAD 2016). Additionally, the quality of healthcare services continues to suffer from serious issues that affect patient safety (Heuvel 2007; Liberatore 2013). It is estimated that more than

134 million adverse events occur each year in hospitals contributing to 2.6 million deaths annually due to unsafe care and around 150 million prescriptions out of 3 billion filled every year are filled with error (World Health Organization 2019; Arthur 2011). Some argue that 95 per cent of healthcare operations do not add value offering opportunities for improvement (Henrique and Godinho Filho 2018). The challenges in the UAE healthcare sector are similar to the global healthcare sector.

The expansion of population in the Middle East has put pressure on healthcare care services (INSEAD 2016). The UAE, part of the Gulf Council Countries (GCC), is one of the fast-expanding economies within the Middle East, intending to make its transition from an oil-based economy to a service-based one. It aims to transform its healthcare sector to become resilient to variances in the international economies and to formulate itself as a reliable and transformative global hub for medical tourists (The Prospect Group 2017). As a result, the rapid population growth has necessitated the addition of many healthcare provisions in the country (World Bank 2013; GMI 2018). An additional 2000 hospital beds are required by 2022 (Nair 2018). To maintain an acceptable quality level and enhance patient satisfaction and safety, UAE health regulators sought joint ventures with international healthcare chains (e.g. John Hopkins and Cleveland Clinic). Moreover, many UAE hospitals are required to seek accreditation (e.g. Joint Commission International Accreditation (JCIA)). Therefore, improved healthcare processes are of importance to the UAE.

Most LSS research focused on developed countries (Brun 2011; Antony 2004), whereas, there is a limited section of research that focusses on developing countries such as the UAE (Albliwi et al. 2017). The UAE healthcare context presents a unique set of challenges when it comes to implementing change initiatives, including quality and LSS. First, the transient nature of the general workforce in the UAE affects how staff in organisations commit to Continual Improvement (CI) initiatives. The expatriate makes around 88 Percent of the UAE population (Global Media Insight 2019) and given many employees are on short term contracts (e.g. 1 to 3 years), the commitment towards CI may be superficial. Moreover, the hierarchical nature of hospitals combining Clinicians (Physicians and nurses), hospital administrators/ management and investors with competing priorities could present another challenge. Clinicians, whose participation and input is much needed during CI initiatives, could be reluctant to participate given their demanding schedules and conflicting objectives (Chiarini and Bracci 2013; Creasy 2017; Matteo et al. 2011). This healthcare context adds another type of challenge, which is the engagement and participation of staff in hospitals which is critical to the success of any CI initiative.

1.3 Motivation and significance of the study

Continuous improvement initiatives such as Lean and Six Sigma can enhance patient safety, improve stakeholders' satisfaction and control costs (Taner et al. 2007; Antony and Kumar 2012; Antony et al. 2018). While various studies have postulated that Lean and Six Sigma implementation can improve the functioning of the healthcare sector (Wickramasinghe et al. 2014; de Koning et al. 2006; Laureani et al. 2013) it is argued that Six Sigma initiatives 'fail' 80% of the time (Macon 2010; Zimmerman and Weiss 2005). Such failures have been attributed to the lack of a model to guide the deployment of the initiatives (Albliwi et al. 2017). Moreover, the success rate of implementing any CI initiative, including Six Sigma, is influenced by several critical success factors. Such factors, called enablers or readiness factors, are related to organisational infrastructure, top management commitment, leadership, teamwork, resources and acceptance of change (Albliwi et al. 2014; Sreedharan and Raju 2016). Many researchers stress that organisations must address certain factors throughout LSS implementation in order to have an effective outcome (Näslund 2013; Laureani and Antony 2012; Noori 2015; Antony 2012; Zhang, Irfan, Aamir, et al. 2012; Alhuraish et al. 2014; Antony and Banuelas 2002; Dubey et al. 2016). However, these factors have not been developed in totality to aid organisations to prioritise their efforts to ensure a successful deployment (Albliwi et al. 2014; Swami and Prasad 2013). This presents a gap for further research.

There are many failures in implementing LSS witnessed by the author as part of his professional capacity in supporting and coaching the implementation of more than 250 quality and LSS projects during the last 15 years. These failures could be due to an apparent lack of clarity on the factors that will ensure a smooth launch and implementation of LSS projects to support the achievement of the operational and organisational goals. Apart from the concern on the lack of understanding on how these factors work together, various researchers have questioned the impact of these factors and their relative importance in furthering an organisation towards success (Al-Balushi et al.

2014; Albliwi et al. 2014; Siddiqui et al. 2016; Aboelmaged 2010; Muraliraj et al. 2018; Sreedharan et al. 2018).

In an effort to assess and enhance healthcare delivery, patient safety and quality of care, healthcare practitioners and academics have developed various healthcare frameworks. Among these frameworks are the World Health Organization (WHO) Patient Safety Framework, the Institute of Healthcare Improvement (IHI) Patient Safety Framework and the Donabedian Framework which acted as a primary foundation for the evaluation of the quality of healthcare organisations all over the world (Ayanian and Markel 2016; Suñol 2000).

Donabedian, a well-known physician, developed a framework for assessing the quality of care, which became the building block for many CI models (Revere et al. 2004). According to WHO, '*The Donabedian model is an appropriate framework for health care assessment and pays particular attention to raising client's awareness, and satisfaction of the outcomes*' (Sardasht et al. 2012, p.50). While the Donabedian framework will be discussed in more detail and compared to other business and healthcare models in Chapter 3, this study adopted the Donabedian framework for its conceptual model for the following reasons (Raleigh and Foot 2010; Donabedian 2005): First, the Donabediam framework provides a sequential overview on how the process and outcome measures as they connect the theory of change to outcomes something which the WHO and IHI frameworks do not articulate very well. If a model only measures outcomes, then the actual changes that occurred in practice can not be linked to outcomes. Moreover, if a model only measures the process, then the outcomes and objectives achieved can not be validated to have changed and the risk remains that the process improved but the outcomes did not. Second, Unlike the WHO and IHI models, the Donabedian framework combines the physical and organisational characteristics where the healthcare occurs (Structure element) while focusing on the care delivered to patients (Process element) and finally linking these activities to the effect of healthcare on the status of patients and populations (Outcome element). This layout integrates very well with the Six Sigma approach that focuses on process and outcome measures. As the Donabedian framework has some limitations, this study expands on the framework by introducing an LSS conceptual model creating a hybrid model based on the Donabedian framework and the Balanced Scorecard (BSC) approach to measure outcomes.

Moreover, there were few empirical studies on LSS CSFs, LSS impact on organisational performance and implementation frameworks (Shafer and Moeller 2012; Uluskan 2016; Sreedharan and Raju 2016). An investigation of the current literature, presented in Chapter 2, confirmed that little research had been carried out exploring the status of Lean and Six Sigma implementation in UAE hospitals. A study to appraise and discuss LSS CSFs in the UAE context while exploring a suitable LSS deployment framework to in UAE hospitals was essential for the following reasons:

1. This study provided the opportunity to examine if there are any specific UAE success factors and barriers during LSS implementation, given the specific UAE context discussed earlier.
2. This study contributed to the understanding if LSS has an impact on hospital performance by testing various models for CSFs clustering and sequencing.
3. The findings will assist UAE hospitals that are contemplating implementing LSS by providing an understanding of what factors are needed before starting the implementation. If practitioners are informed of these factors and are attentive to the influence of critical factors, the LSS initiative is more likely to be successful.
4. This study added to existing theories when it comes to LSS deployment frameworks.
5. This is the first mixed-methods study that examined LSS implementation in the UAE healthcare sector.

1.4 The aim of the study

The study addressed the following aim:

> *To examine whether the Strategic, Tactical and Operational (STO) CSFs are positively correlated with LSS successful implementation in UAE hospitals measured by hospital performance.*

1.5 Research question

In order to achieve the overall aim of this research, the study intended to answer the following research question:

> *To what extent are the STO CSFs positively correlated with LSS successful implementation in UAE hospitals measured by hospital performance?*

1.6 Research objectives

The following objectives were suggested for achieving the above research aim:

1. To examine the extent to which LSS is implemented in UAE hospitals. (OBJ1)
2. To identify the significant LSS CSFs and allocate them to their STO themes in UAE hospitals to develop a conceptual model. (OBJ2)
3. To evaluate the correlations between STO CSFs and LSS successful implementation measured by UAE hospital performance. (OBJ3)
4. To develop a framework for LSS deployment in UAE hospitals clarifying the interdependencies between the CSFs. (OBJ4)

1.7 Research approach and strategy

The research approach presented in Figure 1.1 shows the main research activities. To enhance data collection and to overcome some of the limitations associated with survey studies, the study employed a mix of quantitative and qualitative data collection methods, The following phases were followed in this study:

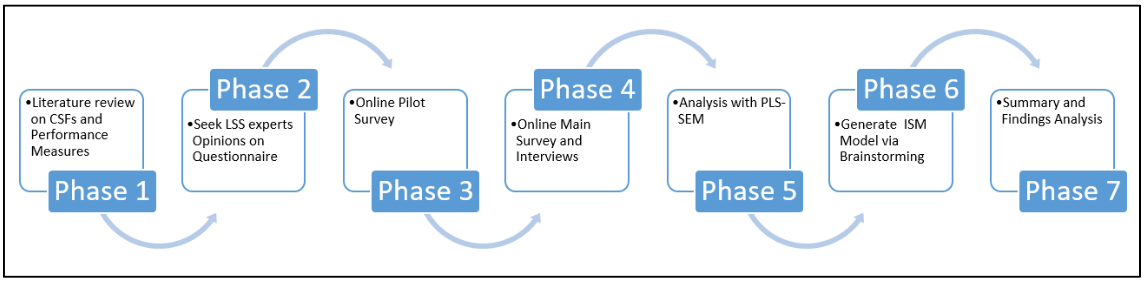


Figure 1.1: Phases of the research strategy
Source: Author

Phase 1 focused on conducting an extensive literature review on Quality, TQM and LSS to extract and prioritise 'Global' LSS CSFs mainly focusing on healthcare. Such a comprehensive literature review allowed for the extraction of significant LSS CSFs themes and hospital performance measures to develop a conceptual model. The review focused on peer-reviewed papers and textbooks. Several comprehensive systematic literature reviews were also consulted to identify CSFs (Albliwi et al. 2014; Antony et al. 2018; Sreedharan et al. 2018).

Phase 2 comprised of designing the questionnaire. Based on a review of similar questionnaires (Laureani and Antony 2012; Douglas et al. 2015; Jeyaraman et al. 2010; Dubey et al. 2016; Hilton et al. 2008; Tran 2006) the study questionnaire was constructed and adapted. The questions and structure of the questionnaire were validated and modified based on feedback provided by various academics and LSS experts.

Phase 3 involved conducting a pilot study using a small subset sample from the target population in order to ascertain and validate the methodology and methods before conducting the main survey. The results from the pilot study allowed the researcher to modify the questionnaire.

Phase 4 involved conducting the main survey on quality and LSS practitioners in UAE hospitals. Additionally, a number of semi-structured interviews were carried out to obtain qualitative views, which were compared with the survey results.

Phase 5 utilised PLS-SEM to evaluate the correlations proposed in the LSS model. The PLS-SEM was chosen as it can provide better insight into casual and exploratory models as it determines how much of the explained variance in the data can be optimised. Moreover, PLS-SEM requires minimal assumptions about the distribution of data and does not require large samples.

Phase 6 utilised an ISM brainstorming session with LSS experts to explore the possible causal relationships between the identified CSFs proposing a deployment framework.

Phase 7 presented the results and findings of the study in relevance to previous work.

1.8 Structure of the thesis

This Thesis is divided into 8 chapters, as follows:

Chapter 1 provides the introduction, background, motivation and significance of the study. The aim, objectives and research question of the study are also mentioned.

Chapter 2 describes the literature review in the suggested areas of research. The chapter encompasses state of the art in the quality field, including quality concepts, TQM, Six Sigma, Lean and Lean Six Sigma integration. Similarities and differences between quality initiatives are also presented. A discussion of the CSFs in the fields of TQM and Lean

Six Sigma along with their impact on organisational performance, is presented. It also discusses the Donabedian classical healthcare framework. Finally, challenges and gaps in the current practices of Lean Six Sigma are highlighted.

Chapter 3 presents the elements of the proposed LSS conceptual model based on the literature review advanced in chapter 2.

Chapter 4 presents the devised methodology in a systematic and organised manner. The research strategy, research design and methods of gathering evidence are explained. The study aim, research questions, objectives and hypotheses are developed.

Chapter 5 presents the pilot study, the main survey details and the graphical descriptive analysis along with analysis remarks with cross-references with previous studies.

Chapter 6 provides the findings of the quantitative and qualitative methods, including the PLS-SEM analysis that aimed to test the proposed models and the hypotheses. Furthermore, the findings of the qualitative analysis of the semi-structured interviews are provided.

Chapter 7 presents the findings of the ISM group session leading to the development of the LSS deployment framework for healthcare (LSSDFH).

Chapter 8 presents the conclusions, contribution and limitations of the study. The practical implications and recommendations are also presented with suggestions for future research.

1.9 Summary

This chapter introduced the background and research problem of the study. It presented the aim, research question and objectives of the study. The justification of the research was provided along with an insight into the research process and methodology that would be followed in the study. The chapter also provided an outline of the thesis chapters. The next two chapters provide a review of the relevant literature and the conceptual model development.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to provide a review of the existing literature to identify where the study could contribute to knowledge. More specifically, this chapter is to provide a review of the performance improvement approaches that led to the fusion of LSS through the evolution of quality, TQM, Toyota Production System (TPS), Lean thinking, Six Sigma and the integration of LSS. Finally, the chapter reviews LSS CSFs and its implementation in the healthcare sector and LSS impact on organisational performance.

2.2 Literature review approach and stages

To better understand LSS as an integrated approach, the author decided to explore the two concepts separately and then as an integrated approach. Precursor CI approaches such as TQM and ISO were also included in the discussions. The inclusion and selection criteria were as follows:

- Papers published in journals with ranking 2 stars and above (ABS journal ranking list). Since LSS is relatively a new field, few relevant papers could be found in 3 or 4 stars journals. It was also decided to include some relevant theses from reputable universities.
- Papers between years 2000 and 2019 although some important papers and books prior to year 2000 were consulted. Very few papers could be found on LSS before 2005 (Albliwi et al. 2014).
- Grey literature was avoided, although some relevant papers from specialised conferences were consulted.

Guided by the above inclusion criteria, the author selected and compiled relevant papers using Mendeley software by reading the titles and abstracts creating topic groups to be further read and synthesised. The author adapted the search process upon consulting several sources and similar papers (Tranfield et al. 2003; Albliwi 2017; Okoli and Schabram 2010).

In Chapter 1, the research question, aim and objectives focused on LSS, CSFs, impact of Lean and Sigma and LSS on performance of organisations and specifically hospitals, the aforementioned keywords were used for searching literature from secondary sources such as journals, conference proceedings, books, professional magazines, and some reliable on-line sources. The following databases were used to search articles on TQM, Lean, Six Sigma, organisational and hospital performance: SCOPUS, Web of Science/Knowledge, Google Scholar, EBSCOhost, Emerald, ProQuest, British Library EThOS, Taylor & Francis and Science Direct. The author also searched in specialized journals which are non-ranked such as Six Sigma forum magazine (ASQ), Quality Engineering (ASQ), quality progress (ASQ), International Journal of Six Sigma and Competitive Advantage (ASQ) and International Journal of Lean Six Sigma (Emerald). Several search terms were used as follows: Critical success factors of Lean, Six Sigma, LSS, Lean and Organisational performance, Six Sigma and organisational performance, LSS and organisational performance, TQM and organisational performance (as there were limited studies in the literature on lean, six sigma, lean six sigma and organisational performance) and included healthcare or hospitals in these searches. The literature search was limited to the English language only. The author also set weekly alerts on Google Scholar and Emerald for relevant new publications.

Moreover, the author identified some useful articles while scanning key papers (Antony and Banuelas 2002; Albliwi et al. 2014; Albliwi et al. 2017; Yadav and Desai 2016; DelliFraine et al. 2010; Vest and Gamm 2009a; Antony, Downey-Ennis, et al. 2007; Antony and Kumar 2012; Waters 2016; Sabry 2014; Proudlove et al. 2008; Laureani and Antony 2012; Antony, Snee, et al. 2017; Antony et al. 2018; Noori 2015; Mousa 2013) reference lists.

2.3 Quality evolution

Previous research argued that while quality philosophies and methodologies have evolved throughout the last 30 years, the principles of improvement and quality stemmed from the fathers of quality such as, Shewhart and Deming's early studies (Shewhart and Deming 1967) on statistical quality control and quality management, Total Quality Management (Feigenbaum 1956), Malcolm Baldrige National Quality Award (MBNAQ), Six Sigma by Motorola's Bill Smith and Mikel Harry (Pande and Holpp 2002; Harry and Schroeder 2000), Lean (Womack et al. 1990) and LSS (George 2003). Many consider the existing LSS programme to be a mere extension of TQM and the original quality and CI concepts. Hence, in order to better understand LSS, one must understand the quality background and its evolution.

2.4 Historical evolution of TQM, Lean, Six Sigma and Lean Six Sigma

The historical evolution of the principles is shown in Figure 2.1, adapted from Upton and Cox (2005). Examining the Figure, one may understand why some researchers label LSS as ‘nothing new’ (Upton and Cox 2005; Snee 2004). They argued that LSS concepts had its roots in the early 1900s when Taylor developed the Time and Motion studies. Indeed, many of the tools used in LSS projects are derived from these early concepts.

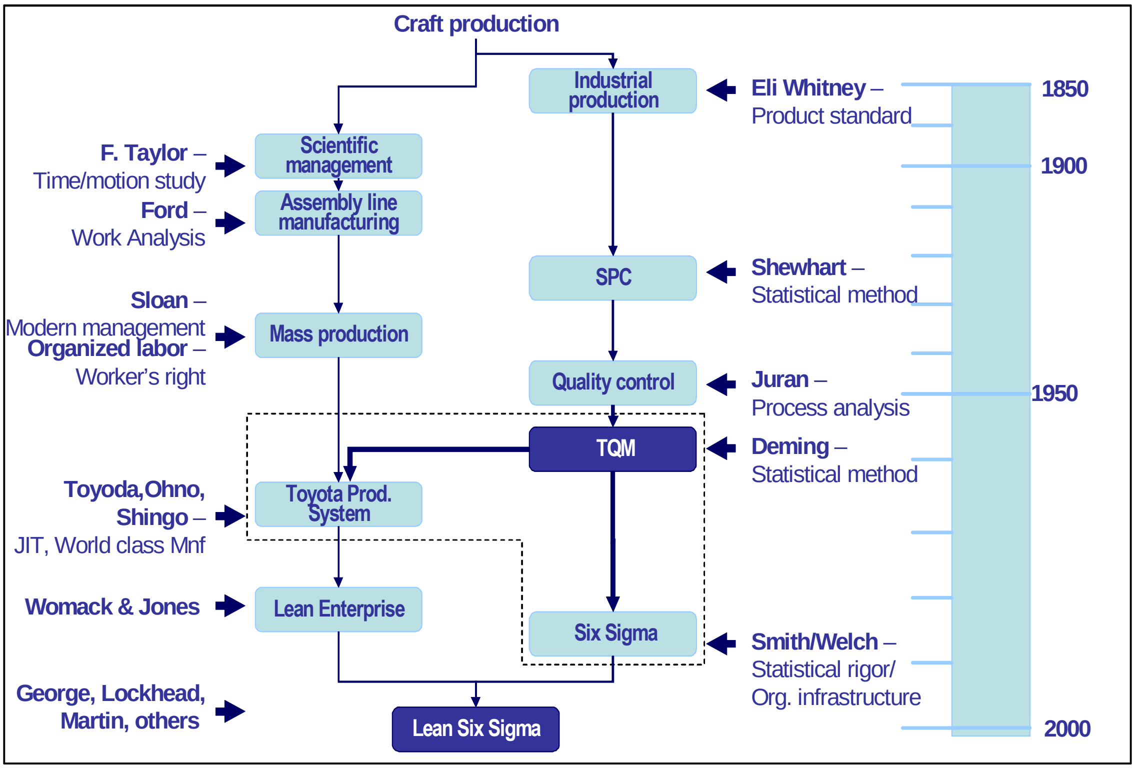


Figure 2.1: History of LSS methodology development
Source: Adapted from (Upton and Cox 2005, p.2)

In the early 1920s, Ford introduced automotive assembly line manufacturing, including one-piece flow and defects control. Around the same time, Shewhart introduced Statistical Process Control (SPC) studies, control charts and the distinction between special and common cause variation as contributors to process problems (Shewhart 1931; Shewhart 1926). In the 1950s, Deming and Juran were busy re-building the Japanese industrial quality systems (Deming 2000; Juran et al. 1999). Deming focused on SPC to understand variation and improve quality levels. SPC became popular in the 1960s and 1970s after its spread into Japanese manufacturing and the 14 points of Deming that contained the blueprint for many continuous improvement methodologies used today (Deming 2000).

By the early 1980s, American organisations were under pressure from their Japanese competitors pressuring them to explore new methods to improve the quality of their processes, achieve lower levels of defects and enhance higher customer satisfaction (Lucas 2002). Realizing that Japanese organisations employed the services of Deming and Juran, American organisations called upon the services of Deming and Juran to help them replicate the superior Japanese quality systems (Deming 2000; NBC 1980). Many argued that this was the spark that led to the American quality revolution and may have led to the birth of Six Sigma at Motorola in the 1980s. The Six Sigma movement was then supported by Jack Welch of GE, who gave Six Sigma its organisational hierarchy and infrastructure supporting its deployment in organisations. At the same time, Toyoda and Shingo of Toyota were perfecting world-class manufacturing principles that became known as TPS and JIT. These principles were fused together with TQM ideas by Womack et al. (1990) and were later called Lean Enterprise principles

The final chapter of the evolution was the integration of Lean and Six Sigma (Upton and Cox 2005). Although the term LSS is said to be first mentioned by Sheridan (2000), it was officially used by George (George 2002) who argued that Lean alone could not maintain a process under statistical control while Six Sigma alone cannot improve process speed. Consequently, Lean Six Sigma constitutes a blend of the concepts advanced in SPC, Deming teachings, TQM, CI, Lean Thinking and Six Sigma to create synergy between these former concepts (Zhang, Irfan, Khattak, et al. 2012; de Koning et al. 2006; Salah et al. 2010; Snee and Hoerl 2007).

In summary, the above discussion has shown that Six Sigma has its origins in TQM principles and ideas crafted by Deming and Juran. Hence the following sections will present TQM principles and their impact on organisational performance leading to the emergence of Six Sigma.

2.5 Total Quality Management

The concept of TQM emerged after World War II as an organisational framework to achieve quality. TQM can be considered as an umbrella term for many of the broad organisational quality and CI methodologies that surfaced as a result of the works of Deming often considered the father of TQM (Black and Revere 2006; Pande et al. 2000; Lindsay and Evans 2005). Feigenbaum (1956) stressed that the primary TQM principle lies in the fact that control must be at the design stage and shall end when the product is in the hands of a satisfied customer. Feigenbaum introduced the idea of deployment of the concepts of quality as a holistic enterprise imitative, where quality becomes the responsibility of all employees, giving TQM its distinctive approach. The previous concept has a strong resemblance to the intent raised by Deming (2000) in his 14 points where he calls to drive out fear from employees, involve them and break down barriers between departments. It can be argued that TQM was developed and matured as a result of the ideas of Feigenbaum (1956), Crosby (1979), Juran (1999) and Deming (2000) although they did not explicitly use the TQM term in their studies.

TQM has many definitions. For example, Juran (1999) defined TQM as a complete system that involved the activities aiming to delight customers, empower employees and achieve higher revenues, while lowering costs. ASQ (2017) described TQM as ‘a management approach to long-term success through customer satisfaction.’ In a TQM effort, all members of an organisation participate in improving processes, products, services, and the culture in which they work. This totality and involvement of staff were highlighted by Ishiwaka, one of the Japanese quality gurus, who argued that TQM is a cross-functional bottom-up/top-down approach to continuous improvement. Some of the benefits of implementing TQM are: increased market share, improved profitability, long-term cost reductions, employee empowerment and retention, increased productivity, innovative work environment, and value-added differentiation (Bawab and Abbassi 1996). In the same vein, many studies have considered the effects of TQM on operations and organisational performance (Terziovski and Samson 1999; Zakuan et al. 2010; Sabella et al. 2014). These studies present several lines of evidence to suggest that there is a positive relationship between TQM and organisational performance. These studies will be discussed in more detail in the next section investigating TQM impact on organisational performance.

2.5.1 The impact of TQM on organisational performance

Many quality programmes continue to be implemented in organisations these days. In a recent global report by the ASQ, 36 per cent of the respondents indicated that quality is considered a strategic asset (ASQ 2016). The issue of correlation (or lack thereof) between quality and organisational performance continues to intrigue many researchers and practitioners. Hence, there is a growing interest in operations literature on the relationship between TQM and organisational performance. As highlighted in previous sections, and since there is a similarity between TQM and LSS approaches and their potential impact on operational and organisational performance, this section reviews relevant theoretical and empirical studies and concludes with the identification of similar trends that can apply to LSS.

Deming's (2000) original chain reaction depicts the impact of quality (TQM) on organisational performance. Figure 2.2 shows the chain reaction graph and how the improvement of quality leads to better productivity and market share. The term productivity can be related to an increase in product quality, process variability reduction, delivery time acceleration, defect rate reduction, or waste reduction. The market share could relate to customer satisfaction and financial benefits. Deming's chain reaction model suggested that quality programmes if correctly implemented, can have a positive impact on organisational performance.

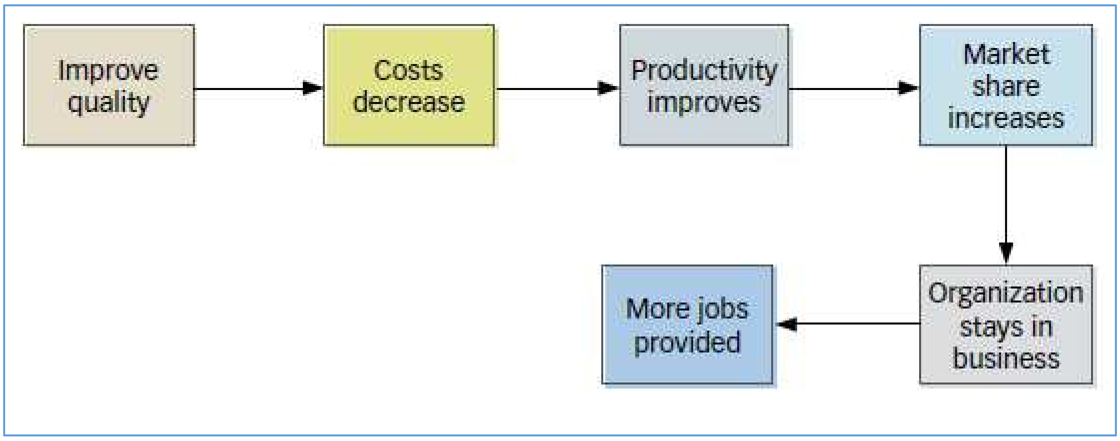


Figure 2.2: Deming's chain reaction and linkage to productivity
Source : (Deming 2000, p.3)

There is a plethora of literature investigating whether the quality and TQM programmes have a positive impact on organisational performance or success. On the empirical side, there is a growing number of studies that have explored the impact of quality initiatives, including TQM, on organisational success and performance. For instance, some studies have reported positive correlations between TQM practices and organisational performance (Terziovski and Samson 1999; Fotopoulos and Psomas 2010; V. Kumar et al. 2009; Demirbag et al. 2006; Jabnoun and Sedrani 2005; Al-Damen 2017). These studies attempted to establish whether a strong correlation exists between TQM practices and various measures of organisational performance. However, a significant proportion of these studies emphasise mere correlation (relationship), with little attempt to test whether it is causal or not.

A number of studies have established a positive relationship between TQM and organisational performance in the manufacturing industry. For instance, Terziovski and Samson (1999) studied the link between TQM practices and organisational performance for Australian and New Zealand manufacturing organisations and established a strong positive relationship between TQM practices and organisational performance. Also, they argued that organisation size; industry type and ISO 9000 certification status strengthen this relationship.

Literature also shows that service organisations that implement TQM have higher operational and financial performance relative to those that do not implement them. For example, Brah et al. (2000) examined the relationship between total quality management and business performance in Singapore's service sector using a questionnaire survey. With regards to the relationship between specific TQM practices and business performance, Brah et al. (2000) reported that business performance is positively correlated with top management commitment, customer focus, employee involvement and training, service design and quality improvement rewards. Similarly, Brah et al. (2002) conducted a study that examined the relationship between individual quality management practices, quality performance, customer satisfaction and employee satisfaction in Singapore. Furthermore, the study investigated whether organisation nature, size and duration of TQM practice affect quality performance. The study was conducted using a mail survey questionnaire sent to 700 quality and operations directors, of which 188 responded. The findings reported a significant relationship between quality performance and behavioural factors, such as top management commitment, customer focus, quality focus, and human resource focus. These results are robust to the nature, size and type of organisation. Moreover, the researchers found that there is no difference in the link between TQM practices and quality performance for manufacturing and service organisations, with both of them reporting significant relationships. Their findings also pointed out that the organization size and length of TQM practice affect quality performance. This result is attributed to the experience organisations gain over time in TQM practice. Lastly, they highlighted that large organisations are more likely to benefit from TQM relative to their smaller counterparts. Similarly, Kaynak (2003) investigated the relationship between TQM and organisational performance for US organisations in a mail survey. The researcher formulated multiple measures for quality management practices and related them to operational, financial and marketing performance. Using Structural Equation Modelling (SEM) and responses from 382 participants, Kaynak (2003) found a significant positive relationship between all seven TQM practices and organisational performance.

Similarly, Salaheldin (2009) investigated the critical factors that underline the relationship between TQM and performance of SMEs, using a questionnaire survey of 297 organisations in Qatar. The researcher further categorised the factors into strategic, tactical and operational themes. The researcher reported that the implementation of TQM has a positive effect on the operational and organisational performance of Qatari organisations. Fotopoulos and Psomas (2010) also confirmed a positive relationship between TQM practice and organisational performance in Greece. Fotopoulos and Psomas (2010) examined the relationship between TQM and organisational performance using a questionnaire survey of 370 Greek organisations and employing SEM analysis. They found that process and data quality management and employee involvement positively influence quality improvements. They also found that top management's commitment to quality practice positively influences quality improvement.

A number of studies focused on the implementation of TQM in healthcare (Sabella et al. 2014; Ali and Alolayyan 2013; Salaheldin and Mukhalalati 2009; Kozak et al. 2007; Talib, Rahman and Azam 2011; Dilber et al. 2005). For example, Dilber et al. (2005) investigated the relationship between four CSFs and business performance in small and medium hospitals in Turkey. The researchers reported a strong correlation with business performance. Their TQM model contained four main factors: data reporting, the role of top management, process management, and employee relations while the performance of hospitals consisted of two dimensions: financial and non- financial factors. However, it is noted that the sample was small (50 questionnaires) and did not cover all cities in Turkey; hence, the results could not be generalized. Similarly, Sabella et al. (2014) examined the relationship between quality management practices and organisational performance, using a questionnaire survey of 51 hospitals in Palestine. The researchers proposed that hospital performance may be related to appropriate TQM constructs, but may have different correlation strength. The researchers developed a theoretical model relating seven TQM constructs to hospital performance. Using analysis of variance and regression analysis, they found that process management, people management, and information analysis were positively related to hospital performance. The researchers reported that leadership and patient focus were positively, but weakly related to hospital performance. On the other hand, the researchers found an insignificant relationship between strategic planning and organisational performance. One limitation of this study was the small sample size. Another limitation is the issue of representation, as this study focused on the West Bank of Palestine, and hence may not be representative of all types of organisations in the country. Talib, Rahman & Azam (2011) conducted a systematic review of TQM studies between 1995 and 2009 and screened 15 peer-reviewed papers. Based on these papers, a model was formulated for healthcare, identifying eight TQM practices and four measures for results. The identified TQM practices were aligned with previous studies namely top-management commitment, teamwork and participation, process management, customer focus and satisfaction, resource management, organisation behaviour and culture, continuous improvement, and training and education. The four measures for results included improved performance, patient satisfaction, improved quality of care, and reduced operating cost of healthcare organisations. Their model is shown in Figure 2.3. This model will be adopted in this study to formulate the proposed conceptual model.

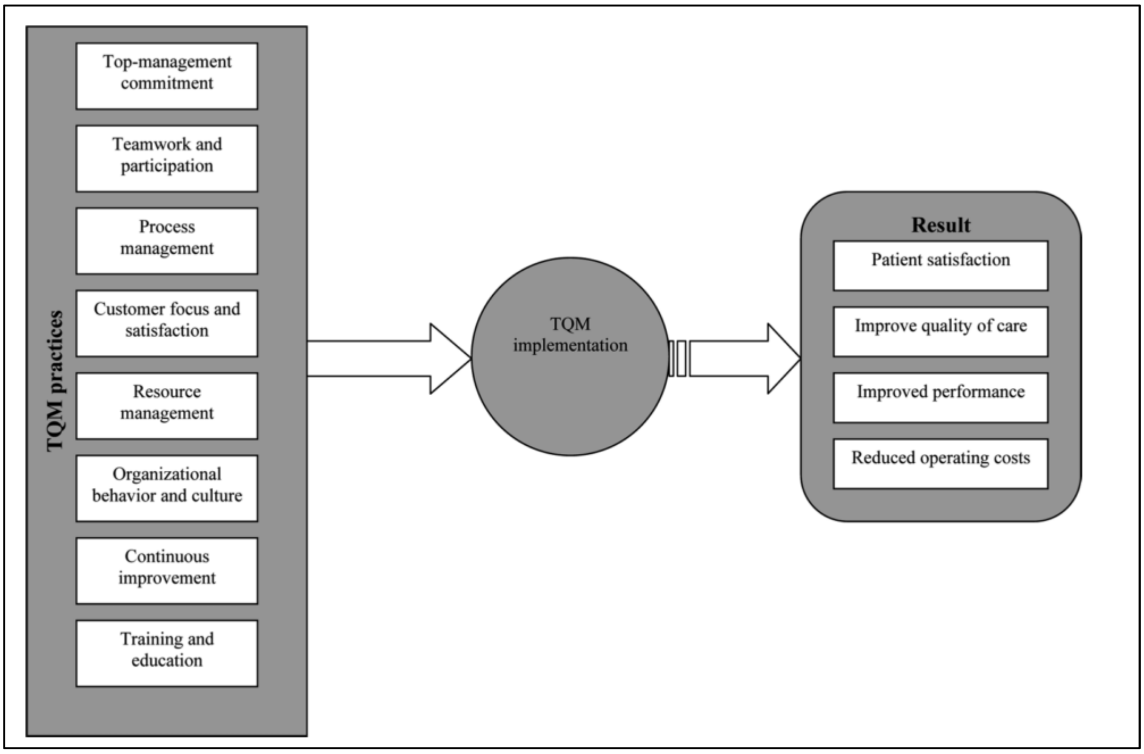


Figure 2.3: Conceptual model of TQM factors in healthcare
Source: (Talib, Rahman and Azam 2011, p.247)

Now the link between TQM and LSS is established, the next section will discuss Six Sigma origins and concepts.

2.6 Six Sigma

As advanced earlier, a number of different CI approaches emerged to focus on improving productivity and reducing cost. Some researchers pointed out that Six Sigma may present an opportunity for organisations to increase their profitability by focusing on customer needs, business objectives and reducing defects and variation in their processes (Pyzdek and Keller 2010; Pande et al. 2000; Harry and Schroeder 2000). Six Sigma definitions and origins are discussed in the next sections.

2.6.1 Six Sigma definitions

Six Sigma has been linked to statistics. Sigma (σ) is a letter in the Greek alphabet that has become the statistical symbol and metric of process variation (Desai and Patel 2009). Statisticians have used this symbol to indicate the standard deviation. From a statistical perspective, Six Sigma has been defined as a metric of process measurement that represents the amount of variation with a normal data distribution where Six Sigma quality level means 3.4 Defects Per Million Opportunities (DPMO) (Aboelmaged 2010).

That makes Six Sigma a data-driven methodology to identify the root cause of process problems and solve them (Antony and Banuelas 2002). Furthermore, Hahn et al. (1999) defined Six Sigma as a business performance improvement strategy, whose primary aim is to minimise defects to as low as 3.4 DPMO. Simply put, the approach is a measure of 'variation about the average', not only in manufacturing but also in service industries (Wei et al. 2010). Moreover, Hahn et al. (1999, p.208) quote the *Financial Times* magazine (Oct 10, 1997) as it defined Six Sigma as 'a programme aimed at the near elimination of defects from every product, process, and transaction.' This definition emphasised the statistical competence that the implementation team should have during a Six Sigma project. The lack of statistical awareness and knowledge of the tools could become a barrier during implementation.

In addition to the statistical term, there are many definitions or descriptions for Six Sigma in the literature (Henderson and Evans 2000). Brady & Allen (2006) indicated that each addressed a different perspective. For example, Six Sigma has been defined as a holistic business strategy that leads to profitability:

> '*Six Sigma is a business strategy and a systematic methodology, use of which leads to breakthrough in profitability through quantum gains in product/service quality, customer satisfaction and productivity.'* (Antony and Banuelas 2002, p.20)

However, Kubiak and Benbow described Six Sigma as a data-driven approach:

> '*Six Sigma is fact-based, data-driven philosophy of improvement that values defect prevention over defect detection. It drives customer satisfaction and bottom-line results by reducing variation and waste, thereby promoting a competitive advantage. It applies anywhere where variation and waste exists, and every employee should be involved.'* (Kubiak and Benbow 2009, p.7).

Moreover, Six Sigma can be considered a system that aims to enhance business success by understanding customer needs supported by data and statistical analysis (Pande et al. 2000). In the same vein, a literature review conducted by Tjahjono et al. (2010) on Six Sigma papers between the year 2004 to 2009 revealed that Six Sigma had been identified and described as statistical tools, an operational philosophy of management, a business culture transformation and an analysis methodology that utilises scientific approach. Similarly, Raju et al. (2016) reviewed 235 papers from January 2003 to May 2015, focusing on how Six Sigma is defined. They identified forty-five definitions and classified them under the following themes: approach, methodology, model, philosophy, programme, strategy, and system. While these definitions may seem different, they describe the same methodology that seeks to achieve the objective of reducing defects and the cost of poor quality. Hence, one can argue that Six Sigma is a blend of a problem-solving methodology, improvement philosophy, set of tools, metrics, statistical tools, business strategy, project approach, and cultural change. This blend may be one of the reasons that made Six Sigma unique and more successful than previous less structured improvement initiatives.

The definitions create different focus areas during implementation creating confusion among researchers and practitioners (Kubiak and Benbow 2009). Nevertheless, each definition brings its unique specific perspective. Some definitions focus on Six Sigma as a strategic programme and system, while others emphasise the structured methodology, as well as the utilisation of statistical methods and tools. Other researchers stress the importance of the organisation-wide deployment as a philosophy (Pande and Holpp 2002; Wortman 2001; Pyzdek and Keller 2010; Gryna and Juran 2001; Coronado and Antony 2002; Hoerl 2001; Linderman et al. 2003; Prewitt 2003; Bolze 1998). In one way, one can argue that the above descriptions are not contradictory, but instead, present a complementary view of the methodology. A similar view can be borrowed from Mintzberg et al. (1998) book *Strategy Safari: A Guided Tour Through The Wilds of Strategic Management* where strategy descriptions and definitions are presented in different ways by blindfolded persons who are approaching an elephant from different areas, and each describes his/her perspective of the elephant without seeing the view as a whole. For example, the person holding the tusk calls it a spear, while the person holding the torso calls it a wall. An analogy can be drawn when defining Six Sigma, where different perspectives are shown in Figure 2.4.

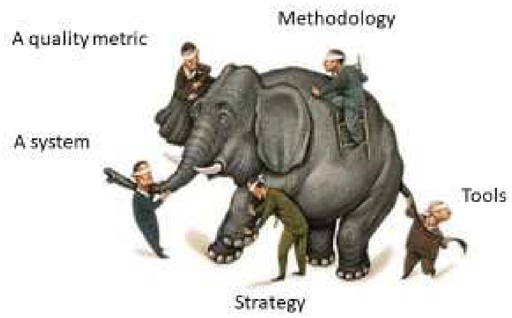


Figure 2.4: The Six Sigma elephant
Adapted from (Mintzberg et al. 1998, pp.2–3)

The author, based on his practical experience as a Lean Six Sigma Master Black Belt (LSSMBB), puts forward a definition for Six Sigma as follows: Six Sigma is a project intended problem-solving methodology led by senior management, supported by trained quality staff or Six Sigma belts and understood by employees. Through its structured methodology, it combines the use of CI and problem-solving tools in addition to statistical tools. Its objective is to enhance customer satisfaction through the reduction of variance and defects, resulting in a positive impact on organisational performance and bottom-line. Simply put, the Six Sigma trilogy approach is based on a structured methodology, supportive organisational infrastructure and utilisation of problem-solving and statistical tools. These three cornerstones become critical for deployment and are addressed in the CSFs section.

2.6.2 Origins and history of Six Sigma

Six Sigma, derived from SPC and CI, was initiated at Motorola in the early 1980s by Bill Smith, one of Motorola's senior engineers, to save its troubled pager business (Meisel et al. 2007). The primary objective of Six Sigma is to reduce defects or errors to enhance process capability by following a structured approach to identify the root causes of process variation. The ideal target is 6 standard deviations between the average of the process and the closest specification limit (Arnheiter and Maleyeff 2005; Wortman 2001; Antony and Banuelas 2002). Having near perfect processes increases the likelihood of products or services that will continuously meet customer specifications and reduce the chance of defects.

To deploy Six Sigma methodology, Bill Smith needed leadership support which he got from Bob Galvin, Motorola's CEO at that time who became the champion of Six Sigma. It is argued that for Six Sigma to succeed it must be driven by a top-down approach (Pyzdek and Keller 2010; Laureani and Antony 2016). Motorola was awarded the prestigious US Malcolm Baldrige Quality Award in 1988 as a result of its efforts in the field of quality and excellence (Pyzdek and Keller 2010; Shah and Din 2016). Afterwards, Six Sigma was further refined and popularised at General Electric with the support of its CEO Jack Welch, at that time, (Pyzdek and Keller 2010; de Koning et al. 2006). Welch advocated the use of Six Sigma, calling it the most significant initiative that GE had undertaken (Welch and Byrne 2003).

2.6.3 Six Sigma deployment methodology

It is argued that the success of the Six Sigma methodology primarily stems from its structured project approach. Hence, the application of Six Sigma requires that organisations adopt a structured methodology to ensure that the process of improving the organisational processes is achieved effectively and efficiently (Voehl 2013; Pande et al. 2000). There are two common methodologies used within the Six Sigma domain. One methodology targets the development of new products and services, called Design for Six Sigma (DFSS) and the other targets process improvement named DMAIC (Define, Measure, Analyse, Improve and Control) (Tjahjono et al. 2010). DFSS is argued to be more effective than DMAIC as it is applied at an early stage of the Six Sigma project (Wang 2008). Tjahjono (2010) listed a number of variations for the DMAIC methodology such as Project-DMAIC (PDMAIC), Enterprise-DMAIC (EDMAIC) and DMAIC Report (DMAICR). Table 2.1 illustrates the key activities that usually occur per stage in the DMAIC structure.

Table 2.1: DMAIC stages and the relevant activities

Six Sigma DMAIC Model	
Stage	Some of the key activities
Define	Define voice of the customer, baseline metrics, scope of the project, problem statement, objectives, team, project charter
Measure	Create a measurement plan, decide on operational definition, measure data, measurement system analysis (MSA)
Analyse	Analyze the causes of defects and sources of variation, find and validate true root cause, Prioritise opportunities for future improvement
Improve	Discuss improvements options to remove variation, pilot suggested tests and validate
Control	Control process variations to meet customer requirements, develop a strategy to monitor and sustain the improved process, train staff and change SOPs, establish control plans

Source: Author. Adapted from (Moosa and Sajid 2010; Pyzdek and Keller 2010)

2.6.4 Critique of Six Sigma

Some Six Sigma supporters claim that Six Sigma projects are raging through organisations with billions of dollars in savings, but detractors argue that it is just a re-packaged TQM and offers nothing new. Stamatis (2001, p.2) goes further to describe Six Sigma as a ‘marketing ploy’ to generate revenue for consultants that are offering no standardised training or coaching. Some argue that Six Sigma supporters have over-exaggerated the benefits of Six Sigma and described Six Sigma as the most popular quality improvement methodology in history (Eckes 2001). Although there are many Six Sigma success stories reported in the literature, there are the sceptics of the methodology. Some estimate that around 60% of corporate Six Sigma initiatives have failed to get any benefits and even led to a negative impact on customer satisfaction (Sony et al. 2018). Critics’ arguments support Genichi Taguchi’s view, author of Taguchi methods for optimising processes, calling for quality to be designed into products and not inspected in. Hence, having a project for Six Sigma is about fixing a process rather than optimising a process (Stamatis 2001; Raisinghani et al. 2005; Sony et al. 2018). Although, one may argue that this statement is not accurate as Six Sigma’s DFSS methodology presents an opportunity to design processes and to build quality within products the first time. The above critique and the need to consider certain CSFs to avoid project failures present an opportunity for researchers to further investigate Six Sigma to enhance successful deployment.

2.6.5 Comparison between Six Sigma and other quality programmes

The Six Sigma approach borrows many principles from Deming, Juran, TQM and SPC (Antony, Snee, et al. 2017; Black and Revere 2006). While Harry and Schroder (2000) argued that 'Six Sigma is a disciplined method of using extremely rigorous data-gathering and statistical analysis to pinpoint sources of errors and ways of eliminating them.' Samatis (2001) critiqued Six Sigma as nothing more than old quality concepts that were around during the last 30 years. He further argued that consultants are using the Six Sigma programme to generate revenue without realising the real value to organisations. On the other hand, a line of evidence shows that Six Sigma may have a positive impact on organisational performance (Goh et al. 2003; Shafer and Moeller 2012; Rahman et al. 2010; Deng et al. 2016; Habidin and Yusof 2012).

The imprints of TQM can be found in many of the modern quality frameworks, quality systems and methodologies such as MBQNA, EFQM, ISO, Lean and Six Sigma (Sower et al. 2016). Some argue that TQM is the underlying concept in all these approaches. For example, Bisgaard and De Mast (2006) argued that TQM has 'morphed into Six Sigma's current incarnation' and contended that critics claim that Six Sigma is just 'old wine in new bottles.' Some argued that Juran's (Juran et al. 1999) trilogy two components, namely quality improvement and quality control are the precursor of Six Sigma's stages of Define, Measure, Analyse, Improve and Control (DMAIC), and his third component of quality planning is similar to design for Six Sigma (DFSS). Hence, it can be argued that Juran's approach to managing quality in projects is embedded in Six Sigma project approach. However, there are some fundamental differences when it comes to structure, statistical emphasis, measuring success in terms of results, aligning projects to organisational strategy and employee involvement (Bisgaard and De Mast 2006; Patyal and Maddulety 2015). Figure 2.5 illustrates how TQM is considered the founding block of current quality approaches.

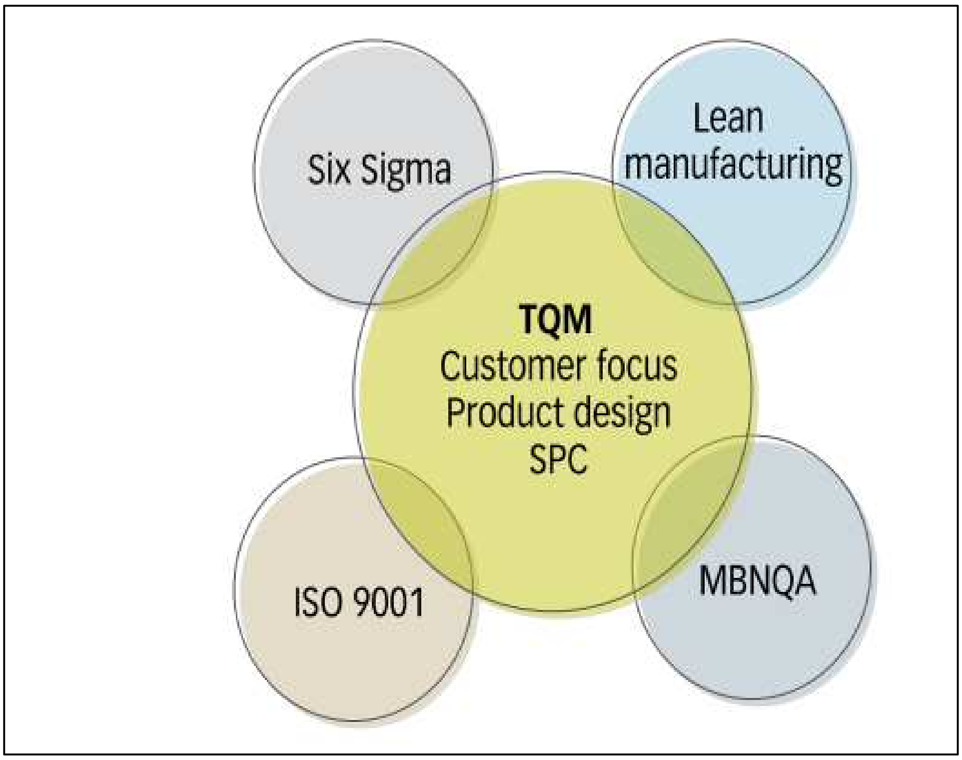


Figure 2.5: TQM overlap with other approaches
Source: (Sower et al. 2016, p.38)

The next section presents a more detailed comparison between Six Sigma and TQM.

2.6.6 Six Sigma and TQM

It is often argued that there is an overlap between the concepts of TQM and other quality approaches such as ISO 9001, Lean and Six Sigma (Andersson et al. 2006; Black and Revere 2006; Green 2006; ASQ 2015). Andersson et al. (2006) noted that Six Sigma and TQM have many similarities, especially concerning origin, methodologies, tools, and effects. Many of these concepts share the same principles through the focus on customers, product design and the usage of SPC tools.

Some researchers argued that the concept of TQM is obsolete (Stamatis 2001). However, their arguments could be flawed as research shows that many TQM concepts are still alive through Six Sigma that can be considered a natural extension of TQM principles and tools (Sower et al. 2016; Green 2006). Kumar (2008) supported this view and noted that DMAIC methodology is derived from Shewhart-Deming's Plan-Do-Check-Act (PDCA)- a TQM roadmap for quality deployment. The Define, Measure and Analyse stages are embedded in the Plan stage, while the Improve stage is included in the Do stage and the

Control is included in the Act stage. Similarly, Tjahjono et al. (Tjahjono et al. 2010) claimed that Six Sigma is nothing more than a repackaged TQM programme is a mere expansion of the PDCA cycle. However, many researchers rejected this claim and argued that Six Sigma is an upgraded approach that requires a structured methodology (unlike TQM), linkage to business needs, strong support from leadership, project management, training on tools and links to financial results (Pande et al. 2000; Anbari and Kwak 2004). It is argued that these factors are the same factors supporting the success of continuous improvement initiatives and TQM (Awan and Bhatti 2008; Salaheldin 2009; Antony et al. 2002). Confirming this view, Blakeslee (1999) agreed that Six Sigma CSFs are an extension of TQM CSFs. These CSFs include top management commitment, integration with business initiatives, process thinking, customer and market knowledge, results-orientation and training. In the same fashion, Black and Revere (2006) claimed that Six Sigma became a 'powerful expansion' of TQM because of the repackaging of some of TQM principles while adding its own concepts. Moreover, Black and Revere (2006) argued that Six Sigma tenets emerged from TQM (often called continuous quality improvement or CQI). The tenets mandated that the whole organisation should support the quality initiative while vigorous education and root cause analysis are emphasised. Many of these tenets concern areas are manifested through Six Sigma's CFSs. For example, top management support and commitment, training and education, adopting the philosophy and culture change CSFs that capture the essence of these tenets are among the most frequent and most discussed in the literature.

When it comes to shared principles, both TQM and Six Sigma require that staff be involved in the deployment. Klefsjö et al. (2001) argued that TQM could be viewed as a comprehensive system that aims to increase internal and external customer satisfaction while reducing resources and capitalising on tools, methodologies and values. The researchers further argued that while the Six Sigma program has many of these common elements, it failed to create the culture to involve everyone in the organisation, as opposed to TQM. On the other hand, one can question TQM's achievement of its objectives of the "totality" of quality in many organisations.

It is argued that various quality initiatives are somehow layered over each other, showing transformation and change over time. Referring to Andersson et al. (2006), Kedar et al. (2008) and Upton and Cox (2008) work, some differences can be noted when comparing

Six Sigma to other quality approaches such as ISO, TQM, and Lean with regards to approach, implementation style, focus and tools. Although some of these perspectives are debatable and literature shows contradicting views on these approaches, many similarities appear in some perspectives. For instance, while many may argue that TQM emerged in Japan at Toyota, others argue that TQM emerged in the US. Similarities appear when discussing the use of tools and customer focus. For example, Six Sigma theory is about reducing defects and deviation where a project will be vetted through the Define stage to establish a firm linkage to the VOC. The same can be said about TQM, where the approach is closely tied to customer needs. Similarly, Lean is based on value definition from the customer perspective while ISO is based on measuring the needs of customers and interested parties.

While one may debate the differences between Six Sigma and TQM, Anbari and Kwak (2004) argued that Six Sigma is a more comprehensive improvement initiative than TQM given its rich data analysis approach, project management, linkage to the VOC, strategy and business needs. Similarly, Upton and Cox (2005) stated that the uniqueness of Six Sigma lies in the infrastructural elements and career development paths that were added to the Six Sigma approach by Jack Welch at GE. Pande et al. (2000) argued that many of the TQM shortcomings are addressed in Six Sigma. For example, the lack of integration with business needs is addressed by Six Sigma's CSF to link a project to business needs and financial results. Moreover, the ineffective training often observed in TQM deployment is addressed by the structured training belt system required in Six Sigma.

Snee (2004) highlighted four aspects of why Six Sigma is superior to TQM. The first aspect is the focus of Six Sigma on the bottom line. The second aspect is about its ability to integrate the human and process elements of improvement effectively. The third aspect is using a structured approach (DMAIC) that links the improvement through the use of tools. The fourth aspect is that it creates an infrastructure of trained professionals (Champions, Master Black Belts (MBB), Black Belts (BB) and Green Belts (GB)) who will lead and deploy the projects). The above aspects generate specific success factors such as leadership support, training, teamwork, project tracking, tools usage, communication, and culture change. These factors are the basis for any successful project deployment. The above findings by Snee are supported by a study conducted by Patyal & Maddulety (2015) that reviewed 67 papers on TQM and Six Sigma and presented a thorough comparison between them. Although Six Sigma was declared superior to TQM; a recommendation was put forward to combine Six Sigma and TQM for better business improvement to overcome TQM limitations (Antony, Snee, et al. 2017; Snee and Hoerl 2005). The first limitation relates to the fact that TQM efforts are not directly linked to the bottom line, which makes management quickly lose interest in the initiative. The second limitation relates to the lack of a structured methodology in TQM, which creates a lack of direction in its projects. The third limitation relates to the lack of organisational supporting systems, including project selection and reporting and budget inclusion. The fourth limitation relates to the lack of measurements and metrics. As a result, TQM could be considered a cultural initiative, and the above limitations will result in misguided efforts and failures with no structured approach. One can argue that Six Sigma methodology emerged to address many of these limitations. Furthermore, the CSFs associated with Six Sigma deployment provide the underpinning needed to overcome these shortcomings.

Finally, it is the learning from the failures of TQM that led to the rise and development of Six Sigma project management methodology that made Six Sigma a 'powerful expansion' of TQM (Black and Revere 2006). The researchers argued that 'Six Sigma has risen from the ashes of TQM with a twist' and pointed out that Six Sigma filled the TQM vacuums by having a more precise definition of quality projects, better project management, and linkage to financials so the management can appreciate the project savings. It is worth noting that many of the CSFs required for TQM implementation are identical to the ones required for effective Six Sigma implementation (e.g. Leadership support and linkage to customer's voice). This study focused on investigating CSFs in Six Sigma projects that are often neglected in TQM. Exploring these CSFs and their impact on organisations performance was a key concern of this study.

It is argued that the lack of an established quality management system (QMS), such as ISO 9001, can hinder the application of Six Sigma methodology (Kumar 2010). It is, therefore, suggested for organisations already enforcing ISO 9001 to carefully integrate their QMS with Six Sigma to attain its full benefits. The next section discusses the relationship between Six Sigma and ISO 9001.

2.6.1 Six Sigma and ISO 9001

ISO word originated from the Greek word 'ISOS' meaning equal and had been used to represent the International Organization for Standardization (ISO). ISO 9001, one of the well-known quality management systems (QMS), is considered a set of good business practices or standards that can be implemented in both service and manufacturing sectors (ISO 2015). The standards are based on seven quality principles. The seven principles are customer focus, leadership, engagement of people, process approach, improvement, evidence-based decision making and relationship management (ASQ 2015).

At the same time, Six Sigma cannot be sustainable in an environment wherein there is a vulnerable QMS programme. It is consequently vital for organisations to first identify their QMS gaps and weaknesses and establish processes. Once processes are established and stabilised, organisations can assimilate Six Sigma correctly to make certain the success of each. This argument is supported by Heuvel et al. (2005) who concluded that Six Sigma is an organisation-wide best improvement method that seeks to reduce defects and cost while enhancing customer satisfaction. This conclusion overlaps with ISO 9001 objectives and makes the integration of ISO 9001 and Six Sigma possible. It can be argued that ISO and Six Sigma share some similarities. For example, ISO requires employees to describe and follow their operating methods, carry out internal audits and continuously provide enhancements. In Six Sigma, a selected number of employees are educated on its methodology and tools and coached to execute projects on processes to attain improvements. Furthermore, each Six Sigma programme and ISO system offers specific systems and techniques. Marques et al. (2013) argued that there are mutual benefits to be realised from the integration of ISO 9001 and Six Sigma programme. Furthermore, the researchers proposed a framework to how the ISO 9001 can benefit from Six Sigma implementation.

Finally, one can argue that ISO quality management and a Six Sigma programme could work together. Consequently, the concept of integrating ISO requirements for sound business practices and the Six Sigma mindset and structure to improve processes has caught the attention of some researchers (Persse 2008; Heuvel 2007; Pfeifer et al. 2004; Marques et al. 2013; Ismyrlis and Moschidis 2018). One may argue that the presence of a QMS such as ISO 9001 could mediate the successful deployment of Six Sigma in organisations (Ismyrlis and Moschidis 2018; Kubiak 2003). However, it is argued that the subject of Six Sigma integration with other QMS is still in its early stages and not enough evidence is warranted to make conclusions (Ismyrlis and Moschidis 2018).

2.7 Lean

The Oxford English Dictionary defines Lean as ‘with little or no fat’. In operational terms, Lean is defined as a set of principles that focus on accelerating the speed of all processes across the enterprise (George 2003). Mastered by Toyota, it is argued that Lean provides a practical set of tools to reduce cycle time in processes. The core purpose of Lean is to identify and eliminate waste in a process (Morgan and Brenig-Jones 2010; George et al. 2005). Lean is defined as the systematic pursuit of perfect value by identifying and eliminating waste in all aspects of the organisation business processes (Womack and Jones 1998). The uniqueness of Lean stems from its focus on the transformation of the organisation mindset to be on the lookout for wastes while, creating a culture of respect for people, accelerating the process speed and creating value for the customer (George 2003).

2.7.1 Origins and history of Lean

Lean can be considered one of the process improvement philosophies (Sunder and Antony 2018). Although there are instances of Lean thinking that can be traced back to the Arsenal in Venice in the 1200 AD, where ships could be built in 6 weeks, the modern traces can be found in the production processes at Highland Park at Ford’s manufacturing processes in 1913. Ford’s impressive improvements in Highland Park and River Rouge plants could be seen as the earliest examples of waste elimination. The improvements included continuous assembly lines and flow systems, one-piece-flow, just-in-time delivery and reduced inventory, pull and production- to- demand not to stock and increase in productivity. Moreover, it can be argued that Lean origins can be traced back to a couple of decades before Ford to Taylor and Gilbreth's waste elimination through ‘time and motion studies’, and then a century before to Whitney's standardisation with ‘interchangeable parts’ in the 1790s.

The introduction of Lean in the western world started in 1990, with the publication of a book on Lean Manufacturing entitled T*he Machine that Changed the World* (Womack et al. 1990). John Krafcik, one of the researchers who worked on the International Motor Vehicle Programme (IMVP) led by Womack and Jones (1998), first used the term ‘Lean production' after studying the Japanese TPS. The concept of Lean management (Lean organisation or Lean thinking) can be traced back to TPS, which represents a method of working towards eliminating waste, or 'Muda' in Japanese (Dora et al. 2013). Lean seeks to reduce or eliminate overburden (muri) and inconsistency (mura) in all operational processes and industries in the process of production (Ohno 1988; Shingo 1989; Antony, Rodgers, et al. 2017). In summary, Lean is a combination of improvement principles focused on improving flow. However, under Lean, the waste of defects and lack of process stability may hinder Lean implementation. Hence, the need for a methodology (e.g. Six Sigma) to stabilise the process and reduce variation becomes critical. As a result, Six Sigma integration with Lean become a much-needed fusion to achieve the best of both approaches.

2.8 Lean and Six Sigma integration, similarities and challenges

Organisations are adopting different approaches to improve the quality of their processes, services and products. These approaches will eventually aim to enhance the organisation competitiveness, provide the customer with the best quality, cost, delivery and nimbleness (Kubiak and Benbow 2009). Recently, two approaches, namely Lean and Six Sigma, were integrated to achieve the above objectives. Many researchers and practitioners pointed out that SPC concepts, Deming teachings, TQM, TPS, Just in Time (JIT), Lean and Six Sigma concepts became fused together over time to form a powerful hybrid called LSS methodology (Black and Revere 2006; Salah et al. 2010). This hybrid approach emerged to address the shortcomings in previous methodologies and capitalise on their strengths (Upton and Cox 2005; Klefsjö et al. 2001). George (George 2002) defined LSS as

> '*A methodology that maximizes shareholder value by achieving the fastest rate of improvement in customer satisfaction, cost, quality, process speed and invested capital.'*

Snee (2010, p.10) agreed with George's definition and described LSS as

> '*A business strategy and methodology that increases process performance resulting in enhanced customer satisfaction and improved bottom-line results.'*

and further argued that LSS is a powerful strategy for process improvement and excellence.

The fusion of Lean and Six Sigma, has been getting lots of attention recently and this hybrid has been “deemed prolific” (Muraliraj et al. 2018; Yadav and Desai 2016; Antony et al. 2016; Raval and Kant 2017). However, since the two approaches originated from different conceptual models, this integration will have to be managed well to capitalise on the benefits of each approach (Pacheco et al. 2015). As discussed earlier, Six Sigma has a keen focus on the use of statistical methods to develop an understanding of existing processes, quantify pain areas and reduce current variations in processes (Antony and Kumar 2012). As such, Six Sigma provides a departure from Lean thinking that is mainly focused on flow and speed (Kumar et al. 2011).

Consequently, understanding the specific requirements of each approach becomes critical before and during implementation. The synthesis of Lean and Six Sigma presents a unique blend, and the fusion is required for the following reasons (Bentley et al. 2010): First, statistical process control cannot be achieved alone by Lean. Second, the speed and flow of processes cannot be accomplished solely by Six Sigma. Third, both approaches will reduce the cost of complexity. As a result, LSS has continued to grow in popularity outside the manufacturing industries to areas such as the public sector, public utilities, and healthcare. Further, Antony (2011) identified the following fundamental differences between Lean and Six Sigma when it comes to the approach to process management and improvement:

- Six Sigma methodology requires more intense training than Lean.
- There could be more investment in resources in Six Sigma compared to Lean.
- Lean is about working on system flow, while Six Sigma is about process variation.

Furthermore, Six Sigma can be considered as an approach to improve accuracy by focusing on variation reduction while Lean focuses on speed by removing non-value added activities, as shown in Table 2.2.

Table 2.2: Differences in Lean and Six Sigma approaches

Approach	Lean	Six Sigma
Waste Classification	Non Value activities	Variation
Focus	Process flow Speed	Problem
Tools	Visual	Statistical
Approach	5 Lean Principles	DMAIC

Source: Adapted from (Antony and Kumar 2011, p.38)

However, each has its shortcomings (de Koning et al. 2006). For example, Six Sigma implementation can be complex and may lack a standard solution. Lean, on the other hand, can be challenging to implement in organisations due to a lack of structure and unclear roles and responsibilities. When Lean is implemented as a stand-alone approach, it may fall short of specific tools to maximise its full potential (Pacheco et al. 2015). Furthermore, Lean may not provide a method for diagnosis and has a limited method for analysis. Snee and Hoerl (2017) argued that there are limitations of the current LSS system, which they labelled as 'LSS 1.3', and hence, it needs to be upgraded to LSS 2.0. They claimed that the current LSS setup is still not appropriate for all types of problems, does not include routine problem solving, is not a complete quality management system, does not utilise big data analytics and does not incorporate modern risk management issues. This indeed may be correct given the vast changes happening around us. Hence, they call for a new paradigm for LSS – 'one of holistic improvement called LSS 2.0'(Snee and Hoerl 2017, p.53). Figure 2.6 shows LSS evolution and Six Sigma versions to date. In their study, Sony et al. (2018) reported 12 significant themes of criticisms mirroring some of Snee and Hoerl's concerns including the need to integrate LSS with Industry 4.0, Big Data and innovation practices.

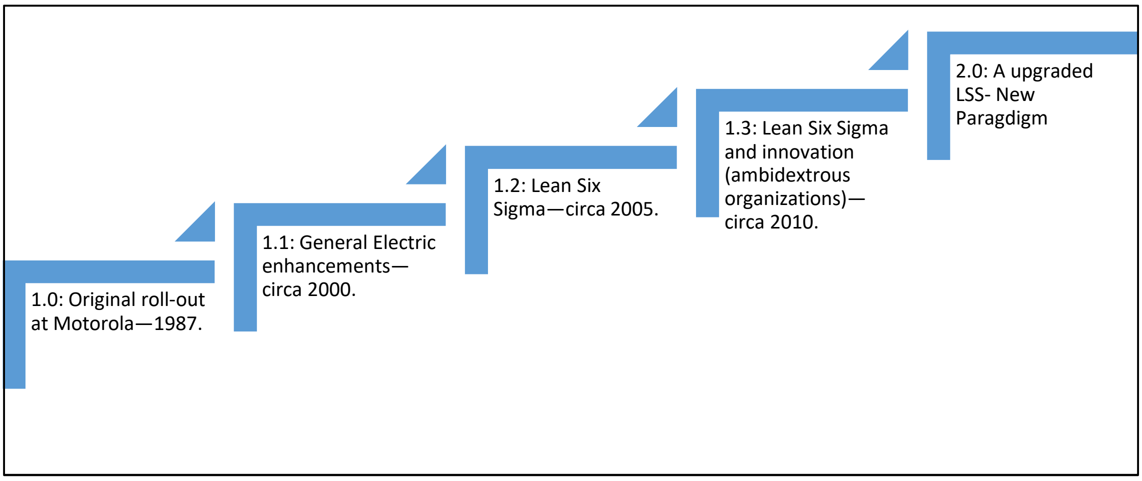


Figure 2.6: Versions of Six Sigma to date
Source: Adapted from (Snee and Hoerl 2017, p.51)

In summary, the integration aims to improve business performance and increase operational efficiency, with the objective being to ensure that the quality of the product is improved and the cost of production is lowered (Albliwi et al. 2014). It is argued that Lean seems to be more participative with a bottom-up approach, which may be different from Six Sigma that needs strong top management support and buy-in (Proudlove et al. 2008). This is due to the fact that Lean thinking depends more on logic and intuition, which stems from employee participation. Regarding staff involvement, Six Sigma focuses on the use of dedicated resources and non-dedicated resources, while Lean makes it the job of everyone, which then may become the job of no one. The focus of efforts synthesises the product and system thinking by using LSS.

While both Lean and Six Sigma are process-centric, Six Sigma tends to focus on product variation, which uses tools to study the system of processes, while Lean focuses on identifying and removing the non-value added steps using the Value Stream Mapping tool (VSM). Moreover, it is argued that while the implementation of LSS introduces a mix of existing tools and techniques, it may bring some unique benefits and challenges (Schroeder et al. 2008).

2.8.1 LSS tools integration

An essential element to support the success of LSS is to deploy the DMAIC framework and complement it with Lean standard solutions and mindset (de Koning et al. 2006). A modified DMAIC where Lean tools are merged within the structured approach of Six

Sigma becomes part of LSS. According to Chiarini (2012) and Yeh et al. (2011), LSS utilises tools and principles that are borrowed from both Lean thinking and Six Sigma. Consequently, LSS will integrate Lean tools with basic or advanced statistical tools through its integration into the DMAIC structure and the five Lean phases, as shown in Figure 2.7. Many argue that the understanding of these tools is an LSS success factor (Bankar 2016; Ismyrlis and Moschidis 2013). However, some researchers argued that LSS extensive toolset and the incorrect selection of the right tools for the right problem could become a barrier for implementation (Sony et al. 2019).

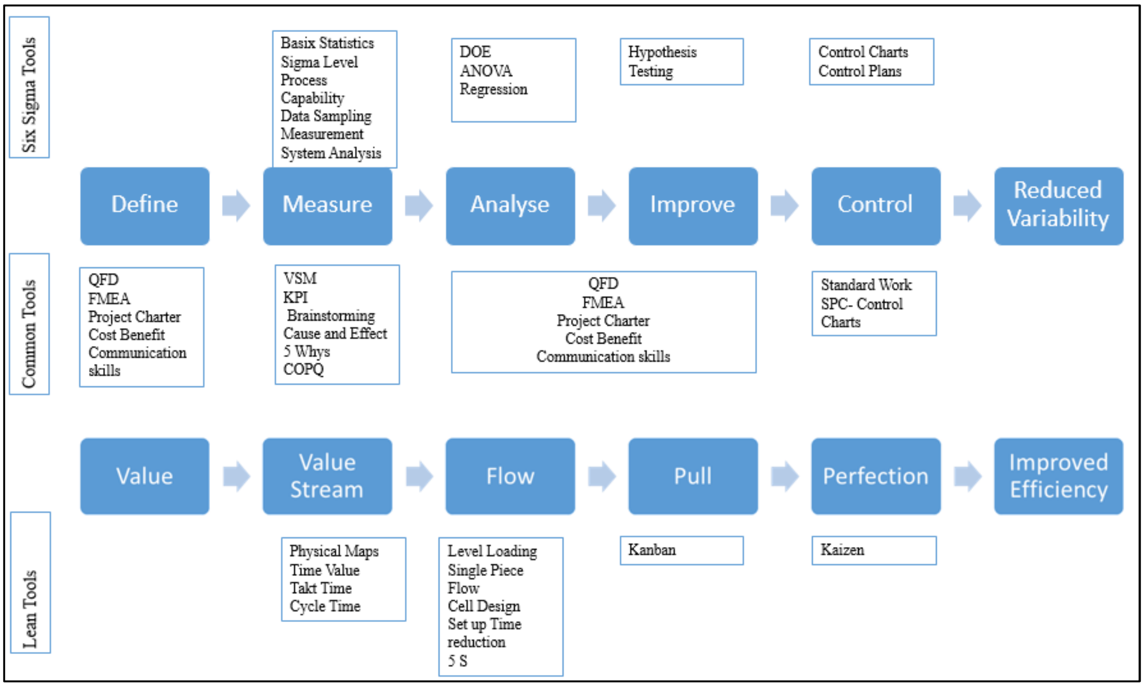


Figure 2.7: LSS tools integration
Source: Adapted from (Pinjari et al. 2017, p.3)

2.8.2 LSS integration challenges

The integration of Lean and Six Sigma has its critics. For instance, Bendell (2006) claimed that LSS had become ‘ill-defined philosophies’ resulting in the dilution of Lean and Six Sigma strengths. The researcher called for a single approach to bring the two philosophies together. Although there appears to be a number of consultants who came up with models for LSS implementation, they provide no logical explanation for their choice of tools and techniques. Other critics claimed that Lean and Six Sigma are incompatible with one another since Six Sigma cannot be embraced by the typical worker (Pepper and Spedding 2010). While some criticise Six Sigma for potentially being biased to sophisticated techniques and analysis and criticise Lean for potentially being naïve and straightforward, this by itself can turn into a strength as individual situations in organisations will require both approaches (Bendell 2006).

On the strength side, Six Sigma is a top-down approach used to tackle variation and defects in processes, while Lean can be used to optimise process flow issues. Lean will not work well if processes are not stable and capable. The lack of stability (out of control processes) can create issues during Lean implementation. Consequently, Six Sigma can be used to stabilise and improve process capability, and Lean can be utilised as a holistic approach to optimise process flow. Lean is meant to improve organisations at an operational level, while Six Sigma is applied to improve processes capability. Furthermore, the LSS framework should be strategic, process-focused, balanced between two approaches and structured, as shown in Figure 2.8 (Pepper and Spedding 2010). This is supported by the findings of other researchers exploring LSS CSF research where the linkage of LSS to organisational strategy emerged as a success factor for LSS (Albliwi et al. 2015; M. Kumar et al. 2009).

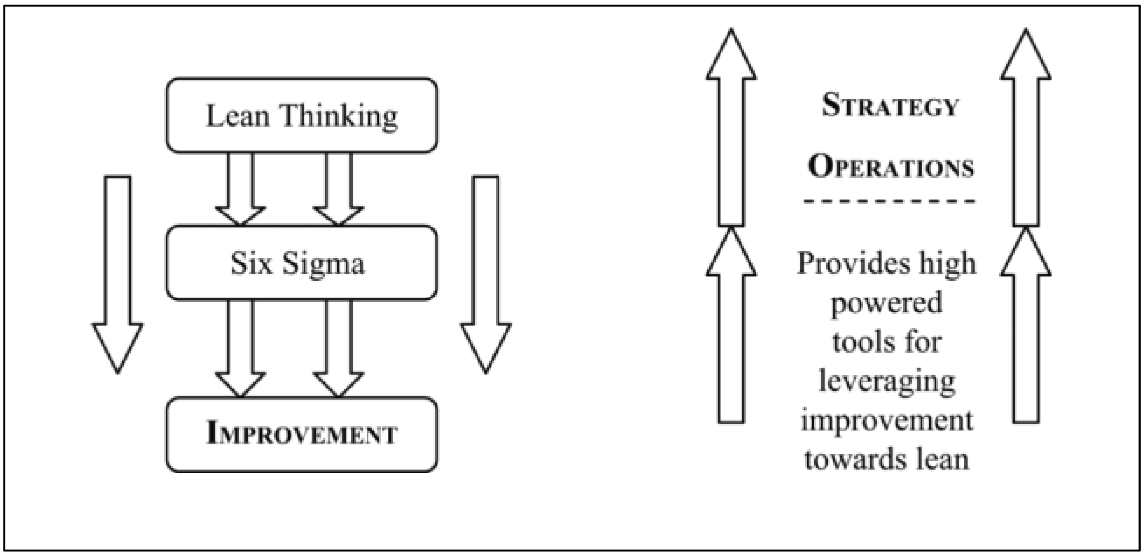


Figure 2.8: Integrating Lean and Six Sigma
Source : (Pepper and Spedding 2010, p.149)

It is evident that the two approaches, Six Sigma and Lean, present opportunities to complement each other as they integrate the human and process aspects of process improvement (Snee 2010; Tjahjono et al. 2010). However, the integration comes with its challenges. The lack of process flow speed tools, people issues, lack of acceptance of change, and weak statistical tools knowledge, as well as an extended project duration (in the case of Six Sigma), are among the challenges that the organisation should focus on (Antony and Kumar 2011).

In conclusion, it is apparent that both Lean and Six Sigma implementation have reported success in different sectors but also have some drawbacks. The literature argued that integrating Lean and Six Sigma can bring in more synergy to organisational processes in the service sectors (Sunder et al. 2018). It is also argued that if Lean is implemented in isolation of Six Sigma, there will be a lack of utilising the full potential of its tools while, if Six Sigma is used alone there will be no structure or strategy to drive its application and may lose the holistic approach (Pepper and Spedding 2010). Furthermore, if an organisation uses one of the approaches (Lean or Six Sigma) alone, it may reach the point of diminishing returns (Arnheiter and Maleyeff 2005). The benefits can be fully realised if both approaches are combined (Antony 2011; Arnheiter and Maleyeff 2005; Bendell 2006; Salah et al. 2010). For the purposes of this study, the term LSS is used to indicate the integration of Six Sigma and Lean. However, it is noted that many researchers tend to use the terms interchangeably when they explore Six Sigma allowing the Six Sigma concept to leak into LSS creating what is called as 'concept leakage'. Hence, while the author refers to Six Sigma studies, these studies in many cases are actually referring to LSS.

Once LSS is implemented, the challenge becomes on how to measure the impact on organisations. The next sections will discuss organisational performance measures and hospital measures.

2.9 Measuring organisational performance

A common notion in business and performance management attributed to Lord Kelvin states that 'what gets measured gets done or gets improved'. Hence, performance measurement is critical to the success of any contemporary organisation. Failure to measure performance can distort employees and gear them away from the organisations' objectives (Pyzdek and Keller 2010; Kaplan and Norton 2005). Literature indicates that the terms 'organisational performance,' 'operational performance,' 'financial performance,' and 'organisational effectiveness' are used with no precise definition and interchangeably (Deng et al. 2016). Add to that; there seems to be no consensus on how to measure an organisations' performance although a number of researchers and practitioners have attempted to define and measure (Yavas and Romanova 2005). Despite that, the literature indicates standard measures for operational and organisational performance.

Typically, organisations tend to focus on short-term financial gains, use unbalanced scorecards, ignoring other key result areas and hence creating an imbalance in their operational activities. Kaplan and Norton (2005) suggested using the Balanced Scorecard (BSC) approach for measures. The BSC is a business-performance model that encourages organisations to create multidimensional measures equally focusing on four perspectives (financial performance, customer performance, internal business process performance and innovation and learning growth performance) (Kaplan and Norton 2001). They argued that having balanced measures is crucial to communicate and deploy strategies and to monitor progress, enabling accurate judgments on the status of initiatives. As a result, some organisations adopted the BSC to classify their measures while researchers started using the BSC approach in their studies to measure organisational performance (Habidin and Yusof 2012).

Apparently, the challenge is to operationalise the BSC four perspectives and measure them while aligning them to strategic objectives. A recent study on the common organisational performance measures and their alignment with the four perspectives was compiled from the literature (Delić et al. 2017). Results of the study are shown in Table 2.3 with the suggested measures from each perspective. It can be argued that an organisation will need to carefully choose the correct measures to track its strategic priorities and initiatives. Since organisations have different strategies and priorities, the selected measures may differ from one organisation to another.

Table 2.3: Organisational performance measures

Financial	**Customer**	**Internal Business Process**	**Innovation and Learning Growth**
Operating income, sales growth, ROI, cash flow, sales revenue, manufacturing cost, economic value-added and capital efficiency	Market share, customer satisfaction, loyalty and retention rate, number of warranty claims, number of shipments returned due to poor quality and number of overdue deliveries	Material efficiency variance, the ratio of good output to total output at each production process, lead time, improvement of workers efficiency, quality of the purchase item, plant utilisation, relation with vendor, rate of material scrap loss, defect rate, setup and changeover time, cycle time, inventory, redesign plant layout and forecasting errors	Number of new patents, number of new product launches, quality of professional/technical development, quality of leadership development, new market development, new technology development, level of employee satisfaction and level of health and safety per employees (e.g., accidents, absenteeism and labour turnover)

Source: (Delić et al. 2017, p.63)

As this study investigates LSS impact on hospital measures, the following section will discuss the common hospital performance measures.

2.9.1 Hospital performance measures

Measuring hospital performance has been very topical in recent years. Additionally, given its unique industry, evaluating service performance in hospitals is critical and tends to focus on healthcare quality improvement clinical outcomes, satisfaction and efficiency (Taner et al. 2007).

However, identifying common measures for hospitals performance can be challenging because of the different operating structures of hospitals (e.g. for-profit, non-profit, government-owned) (Goldstein et al. 2002). The Joint Commission International, a healthcare accreditation framework, (JCI) defines healthcare performance as efforts that continuously improve the processes by measuring services to identify areas for improvement through teamwork. Hospital measures tend to focus on patient safety, performance, patient outcomes and the identification and promotion of best practices (Yavas & Romanova 2005). For example, Yavas and Romanova (2005), in their study of 189 non-profit hospitals in the US, identified eleven measures for hospital performance. They included decrease in duplication of services and facilities, containment of operating costs, increased clinical effectiveness, lower procurement costs, shared risks, less tension between physicians and hospitals, better position in negotiating with insurance organisations, access to new markets, increased occupancy rate, decreased number of personnel per occupied bed and lower total expense per occupied bed. In the same vein, they suggested that these measures are best assessed through questions on patient results, financial and market results, staff and work system results, hospital efficiency and effectiveness results and flexibility. Similarly, and according to Taner et al. (2007), there are broadly six attributes of a healthcare quality system that can be used to measure performance. These include patient safety, effectiveness, patient-centred, timely services and efficiency.

2.9.2 TQM and LSS studies employing hospital performance measures

The introduction and popularisation of interventions such as TQM and LSS in hospitals have encouraged researchers and practitioners to seek an answer to an important question. Do quality interventions have an impact on hospitals performance as an organisation? Consequently, a number of studies have investigated the impact of quality interventions on hospital performance measures.

Sabry (2014), who investigated the factors critical to Six Sigma implementation in Lebanese hospitals, identified the following measures for hospitals performance: efficiency, cost reduction, satisfaction, employee’s service, customer time-to-deliver, quality satisfaction, financial benefits, reduced variation, and financial bottom lines. Similarly, Ali and Alolayyan (2013) identified the following 4 dimensions in their TQM study on Jordanian hospitals: patient result, staff and work system result, hospital efficiency and effectiveness results and flexibility performance. Their study indicated a positive relationship between TQM practices and hospital performance. These results should be considered with caution as the research is subject to the limitations of using questionnaires and more specifically to what is referred to as the 'desirability' factor which may cause the respondents to propagate the goodwill of their hospitals and provide inaccurate responses. However, Dilber et al. (2005) used a combination of financial and non-financial factors to measure hospital performance as a result of implementing TQM in small and medium-sized hospitals in Turkey. The financial measures were revenue growth over the last three years, net profits, return on investment, profit to revenue ratio and cash flow from operations while the non-financial were reputation among major customer segments, capacity to develop a unique competitive profile, new product / service development and market development. Many researchers frequently used hospital occupancy rate, defined as the average utilization rate of hospital beds, as the leading performance indicator in healthcare research with other measures efficiency and financial leverage (Goldstein et al. 2002).

Griffith et al. (2002) classified the following hospital measures according to BSC's four perspectives: cash flow, asset turnover, mortality, complications, length of inpatient stay, cost per case, occupancy, change in occupancy, and per cent of revenue from outpatient care. Similarly, Khaidir et al. (2013) argued that Six Sigma practices (i.e. factors) could lead to organisational performance and used the BSC elements to construct their model, as shown in Figure 2.9.

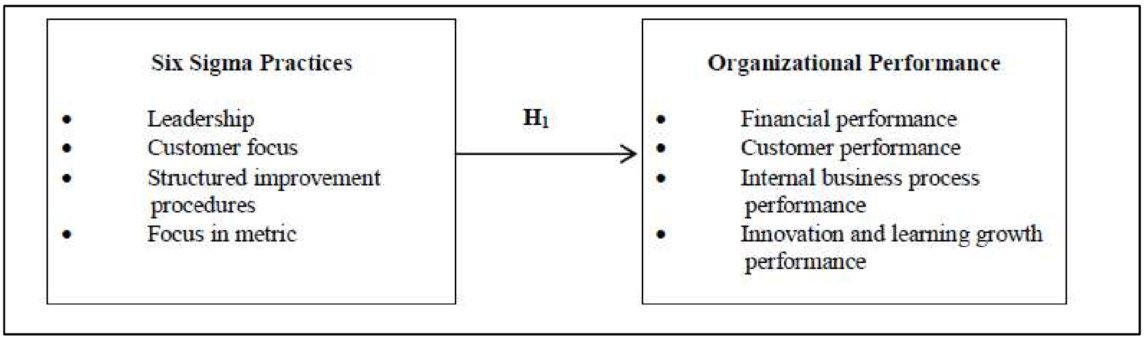


Figure 2.9: Organisational performance measures
Source : (Khaidir et al. 2013, p.34)

The discussion above emphasises that scorecards need to have balanced measurement dimensions, and hence, this study has adopted this approach when setting the hospital measures in the conceptual model.

The next section will discuss the factors needed to support LSS implementation to impact organisational performance positively. As reported by many researchers, the lack of these factors may render LSS implementation efforts futile and weaken its impact on organisational performance (Zailani and Sasthriyar 2011; Tran 2006; Antony and Kumar 2012) hence the discussion of these factors upon LSS deployment becomes critical.

2.9.1 The need for Critical Success Factors

Albliwi et al. (2014) and Chakravorty (2010) reported that 60 per cent of LSS projects failed. Although there are a number of success stories reported on LSS implementation, Moosa and Sajid (2010) and Wasage (2016) reported that there are some companies that abandoned LSS projects, and a small number of organisations reported LSS project success. Some organisations will tend to abandon LSS if they do not realise positive results within a specific time (Leahy 2000). Projects may fail as management and staff tend to become impatient and require results overnight. These findings further emphasise the importance and need to have the appropriate LSS CSFs. If certain CSFs are not present and deployed correctly, the organisation may fail in its endeavours to implement LSS and achieve its planned targets (Antony and Banuelas 2002; Ribeiro de Jesus et al. 2016; Brun 2011; Sreedharan et al. 2018). Hence, the exploration of LSS CSFs becomes one of the main objectives of this study.

The CSF discussion and theory originated from the works of Daniel (1961) and Rockart (1979). CSFs are those factors that are essential to the success of the organisational strategic plans and the achievement of its strategic goals (Rockart 1979). It is argued that there are usually three to six factors that must be done well for an organisation to succeed (Daniel 1961). In the literature, there are many types of definitions for CSFs (Brotherton and Shaw 1996; Antony and Banuelas 2002; Zailani and Sasthriyar 2011). For example, Brotherton and Saw (1996) defined CSFs as the areas that an organisation must work on to achieve the ‘competitive leverage.' Saraph et al. (1989, p.811) defined CSFs as ‘critical areas of managerial planning and action that must be practised to achieve effective quality management in a business unit’.

2.10 Six Sigma, Lean and LSS CSFs

There is a growing discussion in the literature that stresses that specific factors must be put in place while implementing CI to impact organisational performance (Delić et al. 2017). Many researchers have conducted studies focusing on CSFs needed to implement quality systems such as ISO and TQM in different sectors (TQM CSFs in the insurance sector (Bawab and Abbassi 1996), TQM CSFs in industrial sector SMEs (Salaheldin

2009), TQM constructs in the Oil sector (Al-Shammari 2013), TQM CSFs in courier organisations (Sweis et al. 2016) and TQM practices in Jordanian manufacturing organisations (Saleh and Sweis 2017)). Badri et al. (1995) studied CSFs for quality management practices for various sectors' organisations in the UAE to understand their impact and differences. They concluded that the service sector, including hospitals, had a low level of practice with regards to quality, compared with manufacturing organisations.

Researchers have a different understanding of the elements that support the implementation of LSS. Even the used terminology of these 'elements' differs. Literature refers to them as factors, variables, constructs, ingredients, practices, or enablers (Dubey et al. 2016; Yadav and Desai 2017; Martins and Mergulhão 2006; Antony and Banuelas 2002)**.** While some elements are required at the pre-launch stage of an LSS programme, others are necessary at the early implementation stages, and other factors are necessary during the implementation (Deng et al. 2016)**.** Enablers are defined as subsets of CSFs (Soti et al. 2010). The term 'factor' will be used in this study discussions.

The CSF concept was first introduced within the context of Six Sigma implementation by Antony and Banuelas (2002) in their UK quantitative study aiming to identify the 'key ingredients' for effective implementation of Six Sigma in both manufacturing and services sectors. Their study included a sample of organisations that had more than 1000 staff. The CSFs that emerged from the study were management involvement and commitment, linking Six Sigma to customers, linking Six Sigma to strategy and understanding of Six Sigma methodology. One may argue that success factors are derived from Six Sigma various definitions, as discussed in section 2.6.1. For example, the project related definition (Anbari and Kwak 2004) emphasised the project selection, management and tracking skills needed in Six Sigma projects. Manville et al. (2012) definition stressed the need for tool-skills acquisition and training. Similarly, studies illustrated that statistical tools and thinking skill is a success factor for quality improvement initiatives (Tennant 2001; Ismyrlis and Moschidis 2013).

More importantly, it can be argued that the leadership support shown by Galvin was instrumental to the success of the Six Sigma methodology at Motorola and the same applies to GE with Welch's commitment and support to the Six Sigma initiative (Harry and Schroeder 2000). Many researchers supported the above argument and highlighted leadership support and commitment as the number one CSF for Six Sigma deployment (Laureani and Antony 2017; Laureani and Antony 2016; Abu Bakar et al. 2015; Muraliraj et al. 2018; Jeyaraman et al. 2010) which was similar to previous CI studies. For example, Laureani and Anthony (2012) identified management commitment, cultural change, linkage of business strategy and leadership as the critical success factors for LSS implementation. Similiary, Douglas et al. (2015) conducted a pilot study using surveys in East Africa and concluded that the most crucial factor for the successful implementation of LSS is management involvement and participation. Their results agreed with many previous studies, where management support was ranked as the most critical factor (Antony and Banuelas 2002; Desai et al. 2012; Fryer et al. 2007). Some studies solely focused on top management and leadership factor to understand its detailed elements and the expected behaviours of leaders with relation to LSS success (Prasertwattanakul and Chan 2007; Laureani and Antony 2016).

Many common factors were revealed in various studies conducted over the last decade. Several researchers (Al-Balushi et al. 2014; Albliwi et al. 2014; Siddiqui et al. 2016; Aboelmaged 2010; Muraliraj et al. 2018; Sreedharan et al. 2018) conducted systematic literature reviews on TQM, Six Sigma, Lean and LSS CSFs all arriving at similar lists of CSFs. For example, researchers identified 10-25 CSFs for TQM and LSS (Albliwi et al. 2014; Laureani et al. 2012; Salaheldin 2009). In the same vein, a comprehensive review of the literature from the year 1987 to 2015 by Patil et al. (2017) revealed 64 CSFs. The most frequent CSFs were management commitment and involvement and training, education, learning and growth, project prioritisation, selection, reviews and tracking, linking Six Sigma to business strategy, linking Six Sigma to customers, organisational infrastructure and cultural change, and understanding of Six Sigma methodology, tools, and techniques. Simililary, Sreedharan et al. (2018) conducted a content analysis of 41 peer-reviewed papers exploring CSFs of various CI initiatives A Pareto analysis was performed on these CSFs showing that the top LSS CSFs were top management commitment followed by training, communication, customer focus, culture, employee involvement, teamwork, supplier focus and organizational infrastructure. Some papers reviewed Six Sigma CSFs focusing on specific sectors including insurance, banking, construction, electronics, automotive and hospitals (Chiarini and Bracci 2013; Lande et al. 2016; Shah and Din 2016; Jeyaraman et al. 2010; Sabry 2014; Antony and Kumar

2012; Matteo et al. 2011; Siddiqui et al. 2016; Kumar 2010; Al-Sharif 2011; Teo 2010; Tran 2006; Khurshid 2012). These papers arrived at similar lists of CSFs. However, it is noted that certain CSFs could be more critical in one industry or geography compared to others. Moreover, the importance of these CSFs may vary depending on the maturity of the organisation, size, culture, leadership style and sector type.

The evidence advanced above suggests that similar TQM, Lean and LSS CSFs have been reported by researchers in various sectors and geographies. Drawing on the review of the literature, a listing of the common CSFs was established in the table in Appendix A. The author has summarised the CSFs frequency in the literature, as shown in Table 2.4. The final CSF ranking is shown in Table 2.5.

Table 2.4: CSFs frequency according to researchers

	CSF1	CSF2	CSF3	CSF4	CSF5	CSF6	CSF7	CSF8	CSF9	CSF10	CSF11	CSF12	CSF13	CSF14	CSF15	CSF16	CSF17	CSF18	CSF19	CSF20	CSF21	CSF22
(Spanyi and Wurtzel 2003)					1	1				1				1	1							
(Achanga et al. 2006)					1			1											1		1	
(Antony and Banuelas 2002)	1				1	1	1	1		1			1			1	1	1				1
(Fryer et al. 2007)			1		1	1	1		1		1	1	1	1							1	1
(Tyagi et al. 2016)	1		1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1		1
(Laureani et al. 2012)	1		1	1	1	1	1			1			1	1		1		1	1	1	1	1
(Jeyaraman et al. 2010)	1		1	1	1	1	1	1		1		1	1	1	1		1	1	1	1	1	1
(Anbari and Kwak 2004)					1			1		1			1									
(Chakrabarty et al. 2007)			1	1	1			1					1									
(Henderson and Evans 2000)					1								1		1	1		1				1
(Desai et al. 2012)	1				1	1	1	1		1			1			1	1					1
(Sabry 2014)			1		1	1	1		1				1					1				1
(Alsmadi et al. 2012)	1	1	1	1	1	1	1	1		1			1		1	1	1					1
(Soti et al. 2010)		1			1						1		1						1		1	1

(Lande et al. 2016)	1				1	1	1	1	1	1			1	1	1	1	1					
(Manville et al. 2012)	1				1	1				1			1					1				
(Brun 2011)	1				1	1	1	1		1			1	1		1		1				1
(Deng et al. 2016)	1				1						1		1	1					1	1	1	1
(Øvretveit and Aslaksen 1999)					1								1									
(Antony and Kumar 2012)			1		1	1			1													
(Waters 2016)	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1			1
Count	**11**	**3**	**9**	**6**	**21**	**14**	**11**	**11**	**6**	**12**	**3**	**3**	**18**	**9**	**7**	**9**	**7**	**9**	**7**	**4**	**6**	**13**

Source: Author

CSF1 Aligning Six Sigma projects to business objectives. CSF2 Company-wide commitment. CSF3 Established LSS dashboard CSF4 Integration of Six Sigma with Financial metrics CSF5 Leadership and Visible top Management involvement and Commitment. CSF6 Linking LSS to customers. CSF7 Linking LSS to suppliers. CSF8 Management of cultural change. CSF9 Process management. CSF10 Project prioritization selection, management, and tracking skills. CSF11 Quality maturity level of the organization. CSF12 Teamwork. CSF13 Training and education. CSF14 Communication of information. CSF22 Organisational infrastructure. CSF15 Incentive program. CSF16 Linking Six Sigma to employees. CSF17 Understanding LSS methodology. CSF18 Usage of problem-solving and Statistical thinking and tools. CSF19 Availability of resources (financial, time). CSF20 Competency of Master Black Belt and Black Belt. CSF21 Organizational culture

Table 2.5: CSF final ranking

Frequency	CSF Code	CSF description
21	CSF5	Leadership and visible top management commitment
18	CSF13	Training and education
14	CSF6	Linking LSS to customers
13	CSF22	Organisational infrastructure
12	CSF10	Project prioritization selection, management and tracking skills
11	CSF1	Aligning SS projects to business objectives
11	CSF7	Linking LSS to suppliers
11	CSF8	Management of cultural change
9	CSF3	Established Lean Six Sigma dashboard
9	CSF14	Communication of information
9	CSF16	Linking SS to employees
9	CSF18	Usage of problem-solving and Statistical thinking and tools
7	CSF15	Incentive program
7	CSF17	Understanding LSS methodology
7	CSF19	Availability of resources (financial, time)
6	CSF4	Integration of Six Sigma with Financial metrics
6	CSF9	Process management
6	CSF21	Organizational culture
4	CSF20	Competency of Master Black Belt and black belt
3	CSF2	Company-wide commitment
3	CSF11	Quality maturity level of the organization
3	CSF12	Teamwork

Source: Author

Understanding the factors is key to CI deployment and is a concern to many practitioners (Stelson et al. 2017; Manville et al. 2012). More importantly, the question remains if the clustering and sequencing of these factors in a particular format affect organisational performance. The next section reviews clustering models.

2.10.1 CSFs clustering models and categories

Numerous studies have attempted to provide classification and categorisation for the various CSFs identified in TQM, Lean, Six Sigma and LSS studies (Soti et al. 2010; Ismyrlis and Moschidis 2013; Habidin and Yusof 2012; Salaheldin 2009; Hajikordestani 2010; Carmona-Márquez et al. 2016). Figure 2.10 exhibits one of the models that attempted to classify LSS CSFs into five categories (Hajikordestani 2010). These five high-level categories related to management and their support and commitment to LSS initiative, the cultural readiness of the organisation including the infrastructure, the business factors including process approach and linkage to business needs and customers, project control and tracking systems and skills and external factors such as linkage to suppliers.

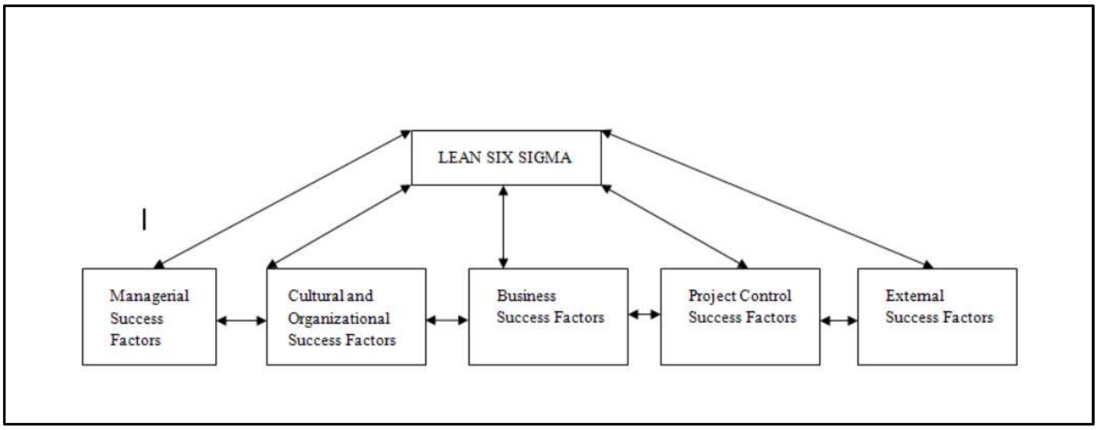


Figure 2.10: Categorisation of CSFs
Source: (Hajikordestani 2010, p.64)

Similarly, Noori (2015) in his study on Lean CSFs in hospitals, classified the CSFs into the following categories or constructs: strategic orientation, organisation structure, management practices, implementation process, and implementation team. Noori tested the relationship between the above constructs and Lean success using SEM and confirmed that all of the constructs have a full significant effect on Lean success in hospitals. In the same vein, Soti et al. (2010) classified LSS CFSs into three categories. The first category related to foundational CSFs enabling LSS launch. An example of this category is management commitment and support. The second category of CSFs is operational factors. These include knowledge of quality and LSS tools. The third category is related to factors that will monitor the sustainability of Six Sigma systems. Examples are linking Six Sigma to suppliers, management information systems, and dashboards.

Some studies used existing management or quality models such as the BSC, EFQM or MBQNA to categorise CSFs. For instance, Ismyrlis and Moschidis (2013) in their literature review presented 32 CSFs and attempted to categorise these CSFs based on EFQM enablers areas (leadership, strategy, people-staff, partnership and resources, processes- products-services). Their study further classified CSFs into soft-hard factors (Kundi 2005). Soft factors are usually related to human behaviour including culture, education, and communication, while hard factors are related to more observable aspects such as tools utilisation, project tracking and structure. Tran (2006), in his study, investigated CSFs for Six Sigma in Canadian manufacturing organisations and classified them into the following categories: financing, integrating strategy, managerial system and educational underpinnings. Tran used the previous categories to design his theoretical model to investigate the relationship of LSS CSFs with financial performance, DPMO, customer satisfaction, the performance of internal processes and suppliers' performance.

The study of Salaheldin (2009) on TQM CSFs impact on SMEs performance identified three categories for CSFs. They are Strategic, Tactical and Operational categories. Strategic factors are long-term enablers that support the launch of corporate programmes such as TQM or LSS where these factors will have a critical impact on the success of LSS deployment (Salaheldin 2009; Ali et al. 2016; Carmona-Márquez et al. 2016; Lamine and Lakhal 2018). Tactical factors are short term practices that are more specific and identify how an organisation implement their strategic plans and will guide organisations' actions impacting employees' motivation and skills (Westcott 2013; Salaheldin 2009). Operational factors focus on day-to-day actions of LSS projects.

In the same vein, some studies employed similar categories used in Salaheldin's (2009) study but adjusted the categories names. For example, Management practice, Infrastructure practices and Core practices (Lamine and Lakhal 2018). Similarly, a white paper discussing LSS failure during launch identified ten CSFs as the main drivers of LSS projects and classified them into three stages (Foundational, Structural and Sustaining) or categories (Macon 2010). The identified CSFs were management commitment and engagement, linking Six Sigma to business objectives, adapting culture, enterprise-wide rollout, communication, linking Six Sigma to customers, project selection and prioritisation, training and education, programme performance tracking and reviews and rewards and recognition. The Foundational stage is where any project gets support from top management and links to business objectives. This stage was similar to the strategic stage discussed earlier (Salaheldin 2009). The Structural stage is where the stability of the projects are supported by the appropriate culture, enterprise-wide rollout, communication, linking Six Sigma to customers, project selection and prioritisation and training and education. This classification differs from the classification by Salaheldin (2009), where culture was listed as a Strategic (Foundational) factor rather than Tactical (Structural). The final stage is the Sustaining stage where Six Sigma programme is monitored and evaluated, and rewards and recognition are provided to team members that complete their projects.

Although the literature presents some studies that aimed at clustering LSS CSFs in various classifications, there is no agreement on the optimised arrangement or sequence. It is also argued that the clustering or sequence could vary between industry sectors and countries. Therefore, this study will develop a model to be tested for the healthcare sector.

2.10.2 CSFs for LSS in healthcare

It can be argued that LSS CSFs for healthcare are similar to other sectors. For example, Antony, Downey-Ennis, et al. (2007) reported the following six CSFs in healthcare: strong top management support and commitment, Six Sigma infrastructure, appropriate training, project selection, the associated financial returns to the bottom line, effective communication at all levels, developing organisational readiness and effective leadership.

Antony et al. (2018) conducted a systematic review of Six Sigma in healthcare and reported 16 CSFs across 6 geographies. The researchers performed a Pareto analysis identifying the following 7 factors that accounted for 80% of the factors: understanding of Six Sigma tools and techniques, management involvement and commitment, communication, organisation infrastructure and culture, training, patient focus and cultural change. Interestingly, the number one factor was understanding of Six Sigma tools and techniques, which is different from previous research but when examing the individual results from the 6 geographies, top management involvement and commitment was the number one factor for America, Europe and Australia while Asia does not report this factor in the top five factors. Similiarly, Waters (2016) conducted a Pareto analysis focusing on LSS CSFs papers related to healthcare between 2000 and 2015, illustrating the top 23 LSS CSFs in terms of frequency of occurrence in the literature. The factors were: leadership and management commitment and support, organisational cultural change, Six Sigma training, aligning Six Sigma projects to business objectives, linking six sigma to customers, project selection, organizational infrastructure, understanding the DMAIC method, tools, techniques, and critical metrics, accountability, tying results to financial terms or bottom line, project management skills and iterating Plan-Do-Study-Act (PDSA) loop, strong communication plan or effective communication, selection of team members and teamwork, selecting the best process, linking to suppliers and HR, clear performance metrics or a measurement assurance system, employee involvement, project tracking and reporting capabilities, supportive IT systems, company-wide commitment, organisation-wide deployment and awareness, availability of resources (financial, time), established clear roles and responsibilities and control phase monitoring to maintain results.

It is apparent that the identified healthcare CSFs were consistent with the literature for other sectors as discussed in section 2.10; however, the ranking was different except for the number one factor, top management support and commitment that ranked number for almost all studies.

The above findings have been considered in the final selection of CSFs for this study. The next section reviews the literature related to measuring LSS implementation and its impact on organisational performance.

2.11 LSS impact on organisational performance

Whether it is a hospital, manufacturing organisation, public service sector or a small business, the need to provide evidence that quality initiatives have an impact on organisational performance becomes critical. Previous studies suggested that if Lean and Six Sigma are well integrated and appropriately implemented, that could have a positive impact on organisational performance (Delić et al. 2017; Sinclair et al. 2005; Arnheiter and Maleyeff 2005).

According to the ASQ survey (2016) on the status of quality globally, there is a disconnect between quality activities such as LSS and the measurement of how these activities impact business performance. The report stated, ‘While there is agreement on the correlation between quality and business performance, the gap in measuring that correlation and articulating it in financial terms points to an opportunity’ (ASQ 2016, p.19). Specifically, it is noted that various researchers in their findings are encouraging more research to empirically explore the impact of LSS on organisations performance in fields such as public sectors, education and healthcare (Antony 2012; Fryer et al. 2007; Heuvel et al. 2005; Knapp 2015; Shafer and Moeller 2012; Sunder et al. 2018).

LSS is an initiative, hence the need for a measurement system to establish the success of its deployment and the impact on organisational performance becomes essential (Shafer and Moeller 2012). The next section reviews measuring LSS impact on organisational performance.

2.11.1 Measuring LSS impact on organisational performance

LSS and other CI approaches such as TQM implementation success can be measured in two areas, that is, operations performance and organisational performance (Jeyaraman et al. 2010; Salaheldin 2009). Operations performance measures are cost reduction, waste elimination, quality of products, productivity, flexibility, delivery performance and revenue. On the other hand, organisational performance is related to revenue growth, net profits, return on assets, competitive profile, new product development, and market development. Similarly, organisational performance is a term that relates to the organisation’s position in the market and its ability to meet its stakeholders’ objectives (Lo et al. 2015).

LSS implementation measurement indicators may include reduction of waste, cutting costs, and reducing non-value added work. These indicators were also linked to the benefits of implementing LSS in organisations (Snee 2010). In a systematic review of 48 studies, de Fretias and Costa (2017) analysed LSS impacts on organisations identifying 25 main impacts that were categorised into three categories: cost, quality and customer satisfaction. Typical measures can address the effects such as cost reduction, increase in product quality, process variability reduction, delivery time acceleration, defect rate reduction, waste reduction, increase in customer satisfaction, acceleration of cycle time, increase in employee satisfaction, enhance the quality of services, processes acceleration, waiting time reduction, unnecessary stock reduction, increase in process efficiency, increase in process flexibility, increase in process productivity, increase in delivered value, error incidence reduction, fostering innovation, better use of space, turnover reduction, cost reduction with stock, increase in team morale, loss rate reduction and processes simplification. The top four impact areas were; cost reduction, increase in product quality, process variability reduction and defect rate reduction.

Deng et al. (2016) conducted a detailed systematic review of studies that examined the relationship between Six Sigma and organisational performance. They reviewed 34 articles, including 30 empirical studies and four conceptual studies. The papers were from the top 14 scientific journals from 12 countries. Seventy-six per cent of the papers came from one country (USA) while 63 per cent were from the manufacturing sector. The researchers found that Six Sigma has a positive correlation with organisational performance while recognising some sampling and method bias with dominant studies.

The researchers concluded that during Six Sigma implementation, specific factors (e.g., training, linking the project to business strategy) must be taken into account. They also found that studies are fragmented across industries with a lack of uniformity. This suggested an opportunity to expand research on this topic in other sectors (e.g. healthcare) and other countries (e.g. UAE).

Previous research proposed specific factors or practices to enhance the success of Six Sigma implementation and its impact on organisational performance. For instance, Shafer & Moeller (2012) conducted an empirical study linking Six Sigma factors such as top management support, role structure, focus on metrics, and improvement procedure to product/service design and process management. Their model linked quality performance to business performance. The study sample of global public organisations was selected using a Google search where organisations indicated they used Six Sigma in the period from 1984 to 2004. Eighty-four organisations' financial data was then obtained from Compustat for analysis. The researchers claimed that studying public data eliminates biases that may exist in self-reported data or misinterpretation when it comes to survey questions. Data were analysed based on Six Sigma organisations' median adjusted performance based on a portfolio of matched control organisations by event year. The researchers used event study method to compare the performance of organisations that adopt Six Sigma to industry benchmarks and control sample of organisations that do not adopt Six Sigma. They showed that Six Sigma impacts organisational performance through employee efficiency, but not through tangible assets. They also observed a significant correlation between better performing organisations and the subsequent Six Sigma adoption. Also, the researchers found that Six Sigma adoption improves employee productivity. The productivity of employees is also observed to be higher if organisations are more experienced in Six Sigma implementation. The main flaw in this study was the indirect approach used to measure the effect of Six Sigma. The researchers assumed that difference in treatment (those that adopt Six Sigma) and control group (those that do not adopt Six Sigma) are entirely attributable to Six Sigma, while other factors could have affected the performance. Some limitations should be considered for the study. For example, data sources could have contained reporting errors since there was no verification process for those organisations that claimed to use Six Sigma and the benefits they realised from the implementation. This has been highlighted as the 'pink factory concept’ (Baxter and Hirschhauser 2004), where organisations may report false data to falsify the level of performance to pretend to be more competent than they are.

Various studies have investigated Six Sigma and its impact on organisational performance through the use of SEM (Kuvvetli et al. 2016; Uluskan et al. 2017). For example, Kuvvetli et al. (2016) conducted a study on Six Sigma projects success using SEM on survey results in Turkey. The success of projects was operationalised by customer satisfaction, a decrease in a number of complaints and a reduction in the rate of defective products besides financial gains. One of the main findings of the study is that project selection and scoping is the most essential factor in the success of Six Sigma projects. This finding was different from the majority of the studies that reported that top management support was the number one factor (Antony and Banuelas 2002; Laureani et al. 2012). It may be reasonable to assume that every country may have different factors and ranking depending on cultural factors, quality maturity and other factors, hence these results may not be generalised.

Some studies clustered LSS CSFs into themes or constructs and tested their link to organisational performance. Wasage (2016) conducted a study based on a survey on US Fortune 500 organisations to study the link between three vital constructs (leadership and management practice, linking Six Sigma to human resources, linking Six Sigma to the customer) and LSS success. The constructs included the following ten vital CSFs: leadership commitment to Six Sigma, upper management commitment to quality, leadership and upper management support of a Six Sigma budget, using customer concerns and feedback to improve quality, employee training on project management, statistical tools, quality commitment, teamwork, and DMAIC/DFSS, open communication between management and employees of Six Sigma projects, providing employee training on Six Sigma belts (GB, BB, Master Black Belt, and Champion), offering rewards and recognition for Six Sigma project employees, Six Sigma training during the hiring process, and overall, training on Six Sigma to reduce employee turnover. The study showed that the following vital components influenced the successful implementation of Six Sigma: leadership commitment to Six Sigma, upper management commitment to quality, leadership and upper management support of a Six Sigma budget, and using customer concerns and feedback to improve quality while training on Six Sigma to reduce employee turnover was the lowest-ranked vital component.. However, the study had serious limitations. First, the study suffered from a limited sample size, where the sample only had 51 responses out of the 500 mailed surveys. Another limitation relates to the use of surveys and the Likert scale questionnaire, where it could be hard to explain why a particular answer was selected. Thus, it may be unrealistic to generalise the results.

It is argued that LSS implementation success can be enhanced provided quality management structures (ISO, TQM, Lean) exist in an organisation prior to LSS deployment (Shah et al. 2008). For example, in their empirical study, Shah et al. (2008) concluded that LSS implementation success would be enhanced if the organisation implemented quality initiatives such as TQM or Lean prior to embarking on LSS. Their findings suggested that the existence of quality models such as ISO, TQM or Lean could be a mediating factor to LSS implementation success. Similiarly, Deng et al. (2016), after reviewing 34 papers on Six Sigma, concluded that Six Sigma has a positive impact on organisational performance and suggested that independent factors, mediating factors, moderating factors and dependent factors should comprehensively be considered when building a model to analyse the link between Six Sigma and organisational performance, In this study, a number of moderating factors including ISO 9001 and accreditation were considered in the proposed model.

While most of the studies reported that LSS has a significant positive impact on organisational performance (Al-Hyari et al. 2016; Sabry 2014; Khaidir et al. 2013; Chandrasekaran and Dhanapal 2008; Habidin and Yusof 2012; Kuvvetli et al. 2016; Deng et al. 2016; Lee 1996; Boon Sin et al. 2015; Wasage 2016; Noori 2015), there is a further need to study the impact of LSS on organisational performance using empirical studies (Schroeder et al. 2008; Deng et al. 2016). This conclusion is supported by Shafer & Moeller (2012), who examined 23 studies and reported that only two studies empirically investigated LSS implementation on organisational performance. Hence, it can be argued that there is a notable paucity of empirical research focusing on LSS impact on organisational performance and the factors associated with successful implementation, as most of the studies use qualitative research and anecdotal summaries (Delić et al. 2017). Moreover, Deng et al. (2016, p.100) argued that although there are some emerging studies on this topic, 'the mechanism between Six Sigma practices and organisational performance is still elusive.'

The next section reviews the literature on LSS implementation in the healthcare sector.

2.12 LSS in the healthcare industry

The adoption of LSS in the manufacturing and service sector has been on the ascendancy over recent decades. Following its success in manufacturing settings, these approaches have gradually been extended to the health sector in many countries (Grunden 2008; Nicholas 2012). According to Shokri (2017), the history of Six Sigma publications from 1992-2013 showed that healthcare, general manufacturing, electronics and automotive articles made up 50 per cent (195 articles) of the total articles released while there were 63 papers on healthcare. Similarly, the history of Lean publications from 1992-2013 showed that healthcare, general manufacturing, and automotive papers constituted 43 per cent (124 articles) of the total articles released and 26 papers focused on healthcare. In the same study, the history of LSS publications from 1992-2013 showed that healthcare and general manufacturing made up 41 per cent (61 articles) of the total articles released while there were 34 papers on healthcare. Additionally, in a recent literature review by Sunder et al. (2018) that covered 167 papers published between 2003 and 2015 on LSS, revealed that 20 per cent of these papers focused on the healthcare sector. Some of the above papers were LSS case studies in hospitals focusing on improving clinical and operational procedures due to pressure from regulators and accreditation bodies (Powers and Paul 2008; Parks et al. 2008; Bhat et al. 2014; Young 2004; Chan 2004; Bisgaard 2009). The above discussion shows the increased interest in LSS research in healthcare and signifies the need to explore LSS in healthcare further.

The research argues that there are benefits to implementing LSS in healthcare. In a systematic review conducted by Antony et al. (2018) on 68 LSS papers in healthcare, 16 benefits were identified and categorised into 5 perspectives. The perspectives were customer or patient focus, financial improvement, operation excellence, people, and compliance. The top 5 benefits that accounted for 68% of the total benefit categories were patient satisfaction, process speed (reduction of process cycle time), revenue enhancement, cost savings, and defect reduction, respectively. It is argued that hospital outcomes and performance measures should align with these benefits.

The question remains. Can LSS become the cure for healthcare organisations? Anthony et al. (2007) investigated whether Six Sigma can improve the financial and operational performance of the UK's National Health Insurance Scheme (NHS). After reviewing related studies in healthcare, the researchers concluded that Six Sigma implementation led to a reduction in laboratory and medication errors and ultimately improved health care delivery. As a result, it was advocated for the NHS to adopt Six Sigma in its health care deliveries. However, the study reported a number of barriers that face Six Sigma implementation in hospitals. These barriers included the initial investment in Six Sigma belt System training, absence, or difficulty obtaining baseline data on process performance, lack of understanding of processes that can be measured in terms of defects or errors per million opportunities which may lead to an inadequate analysis of problem situations and the poor psychology of the workforce given the different services offered by healthcare compared to manufacturing. Likewise, Taner et al. (2007) suggested that the use of Six Sigma principles in health care delivery could reduce delay, measurement and medical errors in the delivery of healthcare. Using five case studies in healthcare facilities that have adopted Six Sigma, the researchers reported that the adoption of Six Sigma led to improved operational and cost efficiency as well as quality. They also found that Six Sigma adoption improved infection control and medication delivery.

Some studies focused on the barriers to implementation and whether Six Sigma leads to higher returns in healthcare (Feng and Manuel 2008; Deblois et al. 2016). For instance, Feng and Manuel (2008) examined Six Sigma implementation in the US healthcare sector in a survey study. The researchers developed a survey that separated 15 Six Sigma adopting healthcare facilities from 41 non-Six Sigma adopting facilities. They found that organisations adopting Six Sigma have a higher return on investment, relative to organisations that do not adopt Six Sigma. Furthermore, hospitals that did not adopt Six Sigma identified lack of commitment from leadership as a significant hindrance to Six Sigma implementation.

Despite the fact that there are recent studies on LSS impact on organisational performance, the application in the healthcare industry is an area that is continuously challenged and needs further exploration (Antony et al. 2018). One may argue that there is an opportunity for more studies investigating LSS CSFs in healthcare given the reported failure rates of LSS projects estimated at 62% (Albliwi et al. 2014; Sony et al. 2018). Morover, Liberatore (2013) reported that only 9 per cent of the 88 hospitals and healthcare providers explored in his study sustained improvement after LSS deployment, while 76 per cent reported improvement in the key process metric. The researcher also reported that only 28 per cent of the surveyed organisations showed cost savings and only 8 per cent reported revenue enhancement results. The researcher argued that these results do not support LSS effectiveness, and this could be a result of not considering CSFs leading possibly to the poor implementation of LSS in healthcare. The researcher called for more research in LSS healthcare applications to maximise its potential.

Hence, it can be argued that poor implementation of LSS in healthcare can be attributed to the lack of understanding of CSFs before starting a project (Liberatore 2013; Pexton 2000). Many researchers also argued that certain CSFs must be in place to achieve the full benefit of Six Sigma in healthcare. For example, Sabry (2014) reached a similar conclusion in a survey study of Six Sigma and its effect on Lebanese hospitals performance. Specifically, the researcher examined the link between 17 Six Sigma CSFs and how they influence nine performance indicators. The study found that there is an effect of Six Sigma on the performance of Lebanese hospitals while reporting that certain CSFs such as closer customer relationships, measurement, organisational structure, zero-defect mentality and planning are not significantly related to the performance of Lebanese hospitals. The top two factors to impact the performance indicators were executive commitment and adopting the philosophy. However, the study showed contradicting results between the two groups examined. For example, the training factor scored low with healthcare professionals versus managers. It is argued that these study findings may not be generalised given it was limited to private hospitals and the small sample size.

Some studies only focused on Lean implementation at hospitals without combining it with Six Sigma. When Lean thinking is applied in healthcare, the concept seeks to create an environment that is stable, while eliminating waste (Ahmed et al. 2013). The concept focuses on ensuring that the errors that occur during the provision of healthcare services are rapidly identified and corrected (Vest and Gamm 2009b). Healthcare employees are therefore on the lookout for areas of improvement, by eliminating wastes, as identified under Lean thinking. From a hospital point of view, the seven wastes include the waste of overproduction, which could occur as a result of repetitive information recording in different forms and documents. Other wastes include time wastage, processing wastes, such as the excessive ordering of diagnostic tests, overstocking of operating rooms, transportation wastes including movement within a healthcare organisation to see patients, and movement wastes to search for documents, as well as patient information. Production defects, as a result of medical errors and the failure to understand the value of healthcare, as perceived by the patients, are also another category of wastes that need to be eliminated when Lean thinking is applied.

Al-Hyari et al. (2016) examined the effect of Lean bundle implementation on hospital performance in Jordan using a questionnaire survey. Using SEM, the researchers studied the relationship between Lean bundle practices such as JIT, TQM and Human Resource Management with the performance of 37 Jordanian hospitals. They found that Lean bundle is positively related to the performance of hospitals, regardless of their size. Given the small sample size, the results may not be generalised.

While some researchers argue that implementing Lean in healthcare will lead to quality improvements, others claim that there is not sufficient evidence to support this argument (Moraros et al. 2016). The researchers conducted a systematic literature review and used a stringent quality control check to select 22 papers from 1056 papers on Lean interventions in healthcare. Based on the 22 papers' analysis, they suggested that Lean interventions have (i) no statistically significant association with patient satisfaction and health outcomes; (ii) a negative association with financial costs and worker satisfaction and (iii) potential, yet inconsistent, benefits on process outcomes, like patient flow and safety. While these results could be regarded as alarming findings, the researchers called for more rigorous and better scientific research to validate claims that Lean could have benefit healthcare operations.

The discussion advanced earlier revealed that LSS implementation in hospitals requires the presence of certain CSFs to enhance success chances leading to enhanced hospital performance. This conclusion drives this study focus, confirms significance and provides the foundation on which the study research questions will be built on.

Many hospitals use a mix of business, performance and healthcare frameworks to help them achieve their goals and track their progress against international requirements for healthcare. The next section will discuss some of the available frameworks and the chosen model used to conceptualise this study model.

2.13 Business and healthcare frameworks

There are a number of business and healthcare performance frameworks that can be adopted in healthcare. Among these frameworks used in the UAE are the European Foundation for Quality Management (EFQM) (Basis for local quality awards frameworks in the UAE), Balanced Scorecard (BSC), Joint Commission International (JCI), World Health Organization (WHO) Patient Safety Framework, the Institute of Healthcare Improvement (IHI) Patient Safety Framework, and the Donabedian framework (Dahlgaard et al. 2013; NIST 2018; JCI 2019; Donabedian 1988; Frankel et al. 2017; World Health Organization 2009). These frameworks were designed with specific objectives and mandates and will be discussed in the next sections.

By definition, EFQM and Malcolm Baldrige National Quality Award (MBNQA) are management models that provide a framework used in gaining a holistic view of an organisation irrespective of the sector, size or maturity (Rowland-Jones 2012; Schulingkamp and Latham 2015). Further, the EFQM model lets managers comprehend cause and effect relationships between the undertaking of their organisation and the results delivered (Suárez et al. 2014). The MBQNA is an award framework and, therefore, was designed to guide those seeking sustainable success through recognition and promotion of quality endeavours in all sector types. It can be argued that the EFQM and MBNQA tend to be generic business excellence models focusing on elements to be in place to help an organisation achieve its operational and business goals and therefore may not be suited entirely for healthcare (Thawani 2014).

The JCI healthcare quality standards, derived from the JCAHO requirements and developed in the US, are becoming popular in the Middle East . In the UAE, the JCI model acts as one of the popular healthcare accreditation frameworks and requires certain elements to be met, including patient safety and infection control to achieve accreditation (JCI 2019). However, the JCI process improvement methodology is not structured to use CI cycles and while a mandate to improve quality and processes is inherent in the standard, there is a challenge to implement an effective improvement strategy based on JCI alone (Devkaran 2014). Moreover, although the JCI encourages CI, it does not describe a specific methodology for improvement; hence, it can be argued that JCI is an accreditation scheme and not a CI model.

The IHI Patient Safety Framework is a model that focuses on safe, reliable, and effective care by examining the key strategic, clinical, and operational components involved in achieving safe and reliable operational excellence. It comprises two foundational domains — culture and the learning system — along with nine interrelated components: leadership, psychological safety, accountability, teamwork and communication, negotiation, transparency, reliability, improvement and measurement, and continuous learning (Frankel et al. 2017). The framework is mainly used as a diagnostic tool to assess how well they are meeting the different components of the framework and not meant to be a CI model.

The WHO framework, shown in Figure 2.11, focuses on the patient supported by a number of factors (e.g. Leadership, capacity building, measurement) aiming for better outcomes (e.g. patient safety, lower costs). One may argue that the sequence of these factors is not clarified in the model hence ignoring the causal relationships between the factors.

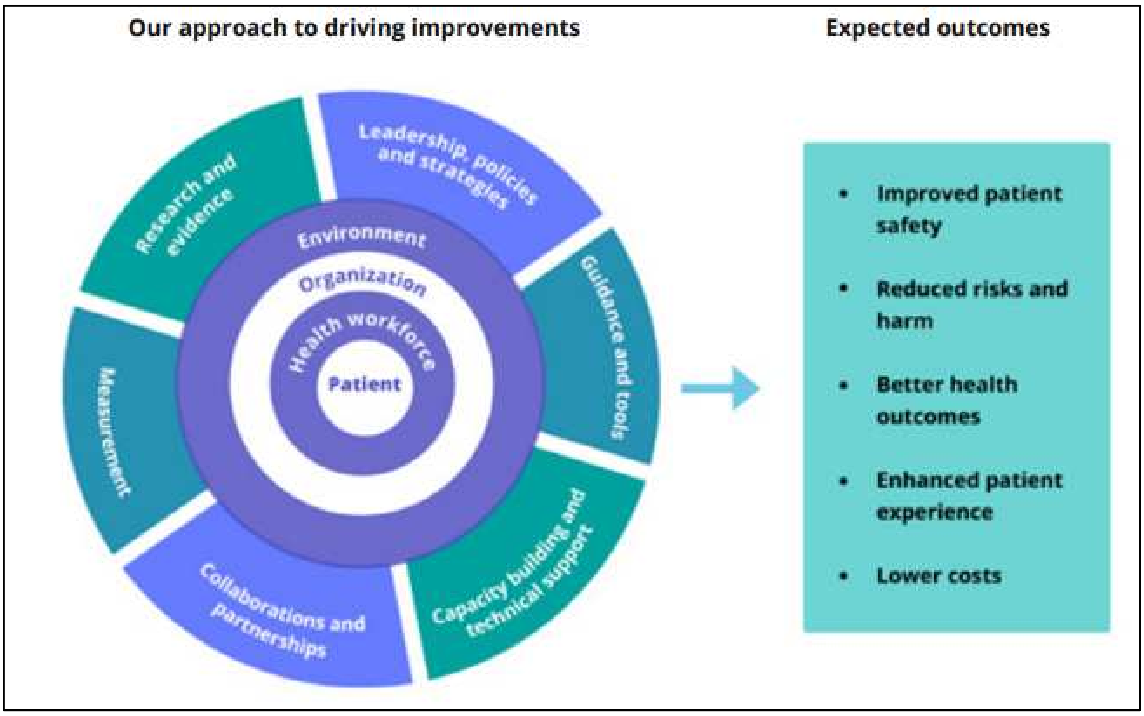


Figure 2.11: WHO patient safety framework
Source: (World Health Organization 2017, p.4)

A systematic review of healthcare studies conducted by Klassen et al. (2009) revealed 97 frameworks adopted to measure and improve healthcare performance. These frameworks ranged in complexity from simple few quality measures to complex ones to measure effectiveness and efficiency. Most of these frameworks were adapted from existing business or quality frameworks. The most common framework was the BSC applied to healthcare using Kaplan and Norton scorecard's traditional quadrants, financial performance, customer satisfaction, internal processes and learning and growth (Kaplan and Norton 2005). The researchers noted that many hospitals were using balanced scorecards to assess the clinical and business processes of specialist practices, their use of resources, the degree to which patients and referring physicians are satisfied with their performance and their patient outcomes. The second most frequent framework was the Donabedian framework adopting a three components approach (structure, process and outcome) for evaluating the quality of care (Klassen et al. 2009, p.47; Donabedian 2005).

The next section focuses on discussing and critiquing the Donabedian framework paving the way to propose an updated model based on LSS.

2.13.1 The Donabedian framework

Research on quality of healthcare systems has traditionally been conceptually underpinned by the Donabedian framework (Donabedian 1966; Donabedian 1988; Donabedian 2005). The Donabedian framework has been widely applied by healthcare researchers because of its simplicity, its focus on conceptualizing the underlying mechanisms that may ultimately contribute to the successful performance of healthcare organisations, and its flexibility for application in diverse healthcare settings and among various levels within a healthcare delivery system (Gardner et al. 2014). Donabedian's articles include some of the most frequently cited publications in the field of quality healthcare management and the model remains the dominant paradigm for assessing the quality of health care.

The Donabedian framework posits that three interrelated dimensions, termed Structure, Processes, and Outcomes, need to be measured in order to evaluate the quality of healthcare organisations (Donabedian 2002). The model predicts that the structures of health care facilities primarily control both the processes involved in health care delivery as well as the quality of its outcomes. According to the Donabedian framework, outlined in Figure 2.12, improvements in the structure of healthcare (measured in terms of how care is organized) will lead directly to improvements in clinical processes (e.g., interactions between patients and healthcare providers) that will, in turn directly result in improvements in healthcare organizational performance (measured in terms of the end results of healthcare practices or interventions).

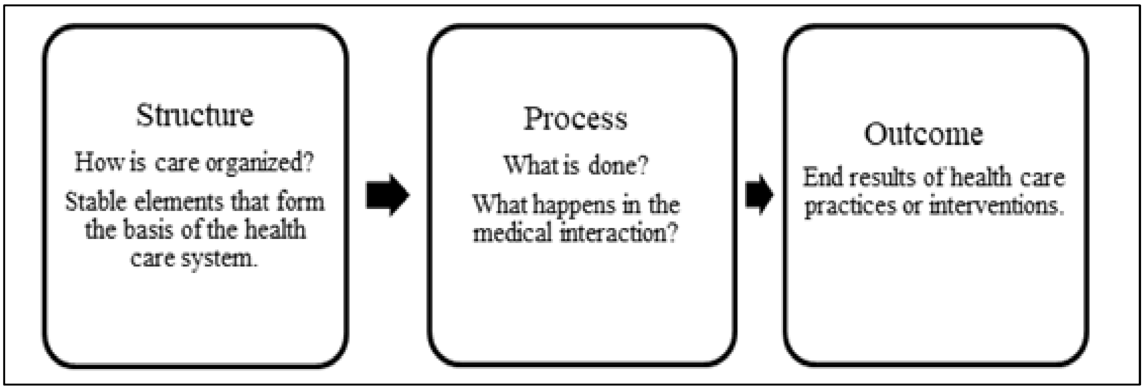


Figure 2.12: The Donabedian framework
Source: Adapted from (Donabedian 2002, p.51)

'Structure' refers to the relatively stable elements that form the fundamental basis of a health care system, including the setting in which care is delivered, its facilities, as well as its equipment, human, and financial resources making structure relatively easy to measure. 'Process' includes what is done in practice by health care systems to provide a high quality of healthcare, including the appropriateness, acceptability, completeness, and competency of the interactions between patients and healthcare professionals (i.e., the patients' activities in seeking care, as well as the practitioner's activities). The measurement of Process includes subjective assessments of quality, and therefore, Process is more challenging to measure than Structure. 'Outcome' refers to the results of health care practices or interventions, including improvements in the health status and survival of patients. 'Outcomes' are concrete events that are also easier to measure than Processes. Examples of Structure elements are patient volumes, accreditation, status, qualifications of personnel, nurse-patient ratios, and teaching status. Examples of Process are the use of evidence-based medications, 'Door-to-balloon time' for acute myocardial infarction and various measures related to screening. Examples of Outcome are hospital standardised mortality ratios, case-mix adjusted mortality, patient satisfaction (Mountford and Shojania 2012).

Donabedian proposed that these three dimensions, and the relationships between them, must be objectively evaluated in order to determine the quality of a specific healthcare organization. This structure is in line with many TQM concepts, including customer focus, the process approach and measuring results (Valmohammadi 2011; Chiarini 2011). This also aligns well with the Six Sigma approach.

In the last decade, the Donabedian framework has been criticized for several reasons (Rubin et al. 2001). First, the model assumes that simple linear predictive relationships exist between Structure, Process, and Outcome; however, the linearity and predictive ability of these relationships have been questioned (Carayon et al. 2006; Mitchell et al. 1998). Additionally, as the healthcare organisational structure is complex, the Donabedian framework appears to have limited utility to predict how the three dimensions of Structure, Process, and Outcome influence and interact with each other. It is difficult in practice (e.g. using a linear regression model) to prove connections in the 3 criteria statistically. This implies that measures of Structure and Process based on the capacity of a healthcare organization to provide adequate care, do not necessarily imply that there will be an axiomatic improvement in hospital performance. Second, it is difficult to determine which factors are components of Structure and/or Process and/or Outcome, because the factors that constitute the three dimensions of the framework tend to overlap with each other (Donabedian 2005). Third, the Donabedian model does not incorporate all of the many complex factors that determine the successful performance of healthcare organisations (Carayon et al. 2006; Mitchell et al. 1998; White et al. 2012).

Nissenson (2014, p.1) argued that due to the many limitations of the Donabedian model, '*A new quality paradigm is needed to help guide clinicians, providers, and regulators to ensure that patients'* lives are improved by the technically complex and costly therapy that they are receiving'. Consequently, research is needed to devise a broader conceptual framework, positing relationships between more complex and comprehensive factors than the factors associated with Structure, Process, and Outcome that were initially proposed by Donabedian.

2.13.2 Choice of Donabedian and BSC frameworks for LSS conceptual model

When comparing the Donabedian framework to other models, it can be argued that MBNQA and EFQM excellence frameworks are not healthcare specific and may fail to address the specific nature of healthcare operations. Therefore when it comes to healthcare specialisation and focus on the quality of care, the Donabedian framework is superior compared to MBQNA and EFQM. The JCI framework acts well as an accreditation framework but does not evaluate the quality of care in a sequential way, as presented in the Donabedian framework. Also, the JCI does not address process improvement methodology in a structured approach compared to the Donabedian model.

It is important for CI projects to have an outcome, process, structure and balanced measures; thus the design of the Donabedian framework to assess performance as a result of process changes supported by the structure (elements or CSFs) makes it a good model for this study (Ayanian and Markel 2016; Suñol 2000). Further, a closer look at the Donabedian three domains reveals similarity with existing CI models stages enabling healthcare organizations to adopt Six Sigma. Hence, it can be argued that the Donabedian approach is analogous to the four stages of Six Sigma: identification, characterization optimization; and institutionalization (Revere et al. 2004). Figure 2.13 illustrates the integration of Six Sigma approach with the Donabedian framework. No other healthcare models have a similar integration with Six Sigma. As this study focused on the deployment of LSS (that is process-focused), CSFs and impact on hospital performance, the Donabedian framework, with its focus on the process approach, was an appropriate blueprint model for this study model.

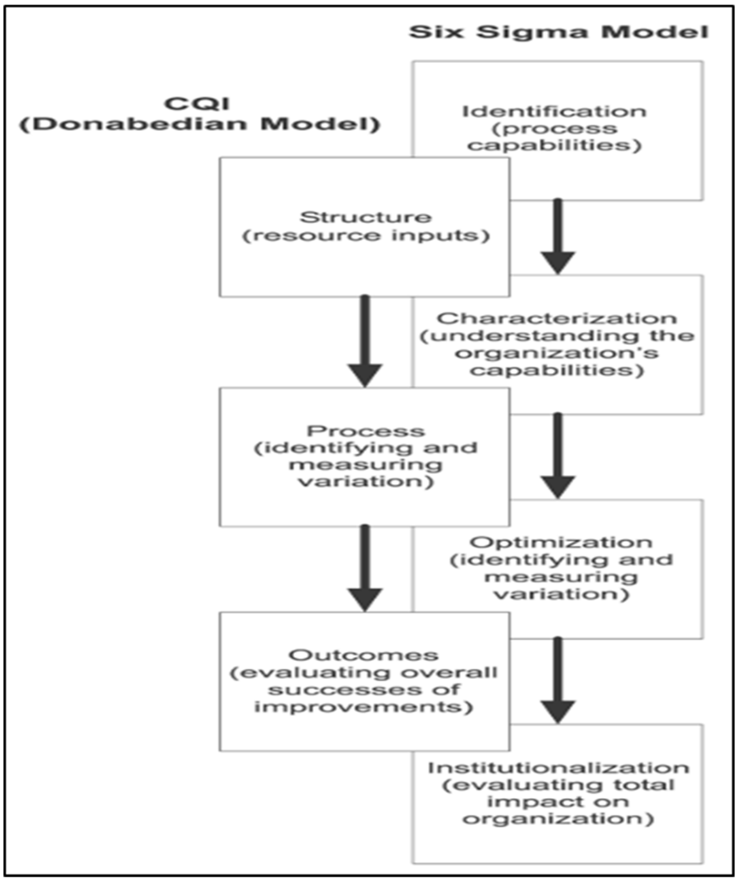


Figure 2.13: Integration of Six Sigma with Donabedian
Source: (Revere et al. 2004, p.109)

Therefore, it was justified for the author to develop and test a 'new quality paradigm' based on a hybrid model from the BSC and Donabedian frameworks identifying the different factors (e.g. CSFs) that may predict the quality of healthcare organisations and their impact on hospital performance as a result of using the LSS approach. The proposed model is discussed in the next chapter.

2.14 LSS status in the UAE

Organisations in the UAE have equally started embracing Lean and Six Sigma despite many of them being highly reluctant due to the poor understanding of the methodology and the presumably high cost of education and training (Shahada and Alsyouf 2012; Al-Sharif 2011). However, evidence shows that the rate of implementation of LSS in GCC countries has been low (Albliwi et al. 2017). The rate of implementation of LSS is less than 32% in Saudi Arabia, UAE's neighbour country. (Aljabr 2015). In addition to the low implementation rates, there is a dearth of publications in the field of LSS in the GCC region. For example, in Saudi Arabia, there were only 11 LSS studies published between 2007 and 2015 (Albliwi et al. 2017).

Within the context of UAE, and as denoted by Al-Sharif (2011), there is a widespread problem of substandard products and services in the UAE despite the intense attention that has been placed by the government towards quality improvement. This implies that it has become increasingly necessary for UAE organisations to adopt LSS for the improvement of quality. On the brighter side, one of the main strengths of UAE resides in its culture of embracing change and acceptance of new ideas such as innovation, Artificial Intelligence (AI), quality and LSS. Examining the literature on quality improvement methodologies in the UAE reveals a growing interest in quality improvement programmes and excellence frameworks such as TQM, ISO 9001, EFQM and JCI (Al-Marri 2005; Al-Dhaafri et al. 2016; Rowland-Jones 2012; Nambiar 2012; Seraphim 2006; Badri et al. 1995). An empirical study on the UAE banking sector by Al-Marri (2005), illustrated that achieving excellence in services requires service quality coupled with the application of TQM and LSS approaches. Moreover, the study identified that the successful implementation of TQM and LSS in the UAE banking sector requires top management support, continuous improvement, service design, customer focus, as well as effective strategies.

Moreover, a global systematic review was recently conducted on LSS studies by Sreedharam and Raju (2016) where a total of 235 papers were identified, and only one empirical study was identified from UAE (Shahada and Alsyouf 2012). Additionally, the author conducted a systematic literature review to identify sources that specifically explored Lean, Six Sigma or LSS in the UAE (Tranfield et al. 2003). As a result, 5 studies were identified (Aboelmaged 2011; Al-Sharif 2011; Shahada and Alsyouf 2012; Al-Aomar 2012; Alosani and Yusof 2018). The details of these studies are shown in Table 2.6. An investigation by Al-Aomar (2012) in the construction industry in Abu Dhabi revealed 27 types of construction wastes and were categorized into seven groups. Defects, including errors and corrections, were found to be the most common type of wastes. Over-processing and delays were also found to be a common type of waste which needed to be reduced. The study suggested the integration of Lean and Six Sigma to eliminate these wastes. Alosani and Yusof (2018) conducted an empirical study to test the hypothesis between Six Sigma and organisational performance using PLS-SEM and concluded that Six Sigma is a crucial continuous improvement tool that has a positive and significant impact on organizational performance at Dubai Police. The study had some limitations as its focus was limited to one specific public sector (i.e. police) and hence may not be generalised to other sectors.

Table 2.6: Main UAE studies on Lean, Six Sigma and LSS

Sector	Method	Findings	Reference
Manufacturing	Case study	Developed a framework to identify the most significant reason for the long lead-time, analyze the root cause(s), suggest three relevant solutions and select the most preferred one.	(Shahada and Alsyouf 2012)
Construction	Case study	Presented 27 types of construction wastes, categorized into the seven types of wastes. Defects (errors and corrections) are found to be the most common type of construction waste in the surveyed companies	(Al-Aomar 2012)
Manufacturing-Cables	Case study-Open Ended interviews	A theoretical framework was developed for Six Sigma implementation Five new constructs were identified- Strategic Initiatives, Cultural Readiness, Learning Capacity, Information Technology Leveragability and Knowledge Sharing Capability, and Network Relationship Balancing	(Al-Sharif 2011)

Mainly service and some manufacturing	Survey Questionnaire	Highlighted the key role of soft impediments, i.e. knowledge and support, and hard impediments, i.e. professionals and finance, as the most influential barriers to Six Sigma implementation. It emphasized the paramount effect of organizational size on successful Six Sigma implementation	(Aboelmaged 2011)
Public service-Police	Survey questionnaire	The results confirm that Six Sigma is an important continuous improvement tool that has a positive and significant impact on the organisational performance of Dubai Police.	(Alosani and Yusof 2018)

Source: Author

The above review revealed there is a dearth of evidence of LSS publications in the UAE signalling low LSS implementation. This calls for more investigation to understand the extent of LSS application in the UAE. This enquiry became one of the primary objectives of this study.

2.14.1 UAE healthcare sector status

Rapid growth is expected in the Middle East and was in the range of 9 per cent between 2014-2018 due to expansion in healthcare care and population growth (INSEAD 2016). The UAE is one of the countries in the Middle East and GCC that witnessed exceptional growth in its healthcare expenditure per capita and is ranked among the top 20 in the world (Deloitte 2011). Given the significant increase in the UAE's population, there is an increased demand for healthcare services. In 2013, UAE healthcare expenditures reached an estimated $16.8bn (The U.S.-U.A.E. Business Council 2014). Further, Alpen Capital consultants projected that the total UAE healthcare market would reach $19.5 billion by 2020 (The U.S.-U.A.E. Business Council 2016). ‘Healthcare has proven to be one of the UAE’s most resilient sectors in the face of international economic woes’ (The Prospect Group 2017). With its aim to become a global hub for medical tourists, the UAE has a unique position in the region that is supported by its clear strategic directions and vision. For example, Dubai’s strategic plan 2015 and Abu Dhabi’s economic vision 2030 ,inspired by the UAE vision, are supporting the drive towards diversification and focus on growing sectors, including healthcare. The UAE vision states that ‘UAE will invest continually to build world-class healthcare infrastructure, expertise and services in order to fulfil citizens’ growing needs and expectations.’

In terms of the healthcare sector structure, there are a number of regulators both at the federal and emirate level. On the federal level, there are the Ministry of Health and Prevention (MOHAP), the Insurance Authority and the Nursing and Midwifery Council. On the emirate level, there are the Health Authority-Abu Dhabi (HAAD), Dubai Health Authority (DHA), Dubai Healthcare City Authority (DHCA) and Sharjah Health Authority (SHA). Each of these entities is responsible for their own member’s licensing and regulations. Further, the UAE healthcare sector is divided between public and private healthcare providers. Three public sector institutions (Abu Dhabi Health Services Company (SEHA), DHA, and MOHAP) play a significant role in regulating UAE healthcare operations. Around 34.6 per cent of the hospitals in the UAE are owned by MOHAP. These hospitals provide most healthcare services in addition to specialised services. Figure 2.14 shows the breakdown of MOHAP operators, while Table 2.7 shows the distribution of UAE hospitals by type and location. Given that 63.3 per cent of hospitals is private hospitals that are typically driven by business drivers including profitability and cost control, questions arise about the success of quality initiatives that usually require investment in training and allocation of resources.

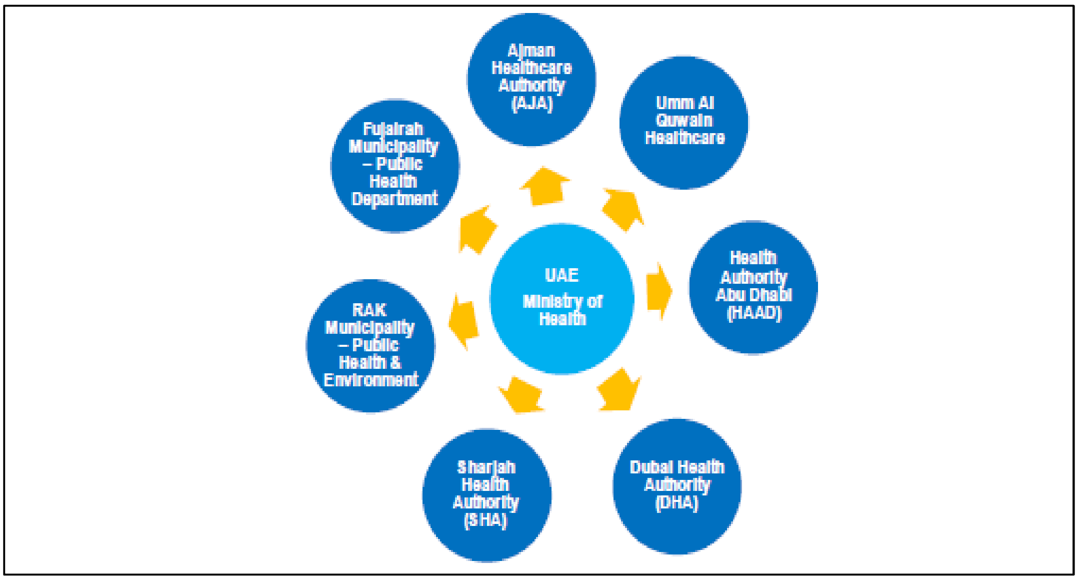


Figure 2.14: UAE healthcare breakdown
Source: (Colliers International 2013)

Table 2.7: Distribution of UAE hospitals by type and location

	Government	**Private**	**Total**
Abu Dhabi	15	40	55
Dubai	5	32	37
Sharjah	5	10	15
Other Emirates	8	4	12
Total	**33**	**86**	**119**

Source : Author. Adapted from (The U.S.-U.A.E. Business Council 2014; Emiratesdiary 2015; HAAD 2016)

However, there are a number of challenges facing the growth of the UAE healthcare sector. Hospital operators in the UAE and GCC are facing the rising cost of healthcare services where gross medical inflation ranged between 5 and 12 per cent during 2017 (Nair 2018). Additionally, there is a shortage of medical professionals and inconsistent quality in healthcare delivery according to a recent report by Alpen Capital (Ahmad et al. 2018). Other challenges include attraction, retention and development of qualified healthcare professionals, quality and standardization of services, cost and complexity of regulatory requirements and licensing, the low premium strategy from insurance providers and a lack of confidence in the UAE's health system (Deloitte 2011). An INSEAD report suggested drafting new policy directions to address the healthcare growth to meet the vision of the UAE (INSEAD 2016). One of the reports' critical suggestions is to develop a national medical innovation strategy to clarify the roadmap to put the UAE among the 10 top countries in healthcare innovation. One may argue that there is a golden opportunity for the UAE to utilise quality improvement methodologies such as LSS which aligns with innovation to develop its healthcare practices (Salah 2017).

According to Heuvel et al. (2006), LSS is a programme that can present opportunities for healthcare providers to overcome conflicting goals. In the healthcare sector, LSS is usually applied in operations management and process management where it may enhance the efficiency of internal operations, increase productivity, improve quality and contain costs (Furterer 2014; Laureani et al. 2013). The next section reviews the extent on LSS application in the UAE healthcare.

2.14.2 Status of Lean, Six Sigma and LSS in UAE healthcare

According to Hussain et al. (2016), Lean is now being expanded beyond the manufacturing companies into the field of healthcare management. Hussain et al. (2016) proposed an Analytical Hierarchical Process (AHP) framework for assisting Lean deployment in the Abu Dhabi public healthcare delivery system by studying three public hospitals. This proposed framework was based on the assessment of the local situations by experienced healthcare professionals, and it resulted in the ranking of 21 healthcare wastes. Moreover, the study found that the management of Abu Dhabi healthcare systems placed more emphasis on inventory waste. In the healthcare sector, there are various stakeholders with unique needs and expectations that need to make use of LSS. The physicians and caregivers need Six Sigma to foster clinical outcomes as well as diagnosis treatment by improving the experience of patients, their physiological wellbeing as well as reducing delays and waiting time (Abuhejleh et al. 2016) .

Drawing on the personal experience of the author as an LSS practitioner since 2003 in the GCC region, the following was noted. The number of Lean or Six sigma courses conducted by the author in the Middle East and GCC (Yellow, GB and BB level) from 2003 to 2017 was 54. However, it was noticed that the bulk of the courses were run after 2010. The author noted a significant lack of awareness in Lean and Six Sigma between 2003 and 2009. It was just after 2010 that an increased awareness was observed, leading to higher demand for LSS training courses. This increase in training interest could have indicated the growing quality maturity of organisations in the region. Moreover, the total number of participants who attended LSS related training was over 600 participants (In-house and public training sessions). Those participants trained by the author attended a 3-7 day training session on Lean, Six Sigma or LSS representing different sectors including manufacturing, oil and gas, government, banking and healthcare. The LSS GB courses required participants to submit a project within 8 months of the completion of the training. The number of LSS projects successfully submitted and signed off during the above period was 65 projects. There were 5 projects in progress (As of February 2018). However, 27 projects were not completed, although a project charter was submitted and accepted. Feedback from the 27 project leaders indicated that these projects were not completed due to lack of top management support, lack of resources, lack of project data and baseline process metrics and lack of understanding of the LSS philosophy in the organisation. These factors mirror the findings by many of the researchers on CSFs advanced earlier in the literature.

In summary, it can be argued that there is limited literature on LSS, focusing on its applicability in the UAE healthcare sector. Moreover, LSS implementation is an area that needs to be further explored. This becomes one of the main objectives of this study.

2.15 Research gap

The literature revealed that Lean, Six Sigma and LSS studies remain limited in their focus on exploring specific countries and sectors (Albliwi et al. 2017; Muraliraj et al. 2018; Sreedharan and Raju 2016; Shokri 2017). Consequently, some questions are raised regarding LSS applicability and success in non-manufacturing sectors and in developing countries. Although the current literature shows a surge of studies (Albliwi et al. 2014; Alidrisi 2014; Laureani and Antony 2017; Sabry 2014; Sreedharan et al. 2018) on LSS CSFs in specific sectors and geographies, few of them addressed LSS in healthcare. For example, out of the 235 global papers published between January 2003 and May 2015, only 33 papers were in healthcare (Sreedharan and Raju 2016). Similarly, in a comprehensive study on LSS publications between 2000 to 2016, only 11.1 per cent focused on healthcare case studies (Muraliraj et al. 2018). Furthermore, a quantitative analysis of Lean, Six Sigma and LSS studies within the last decades conducted by Shokri (2017) revealed that while there is a growing interest that resulted in a surge of LSS publications, these studies have been limited to specific industries and countries. This presents an opportunity to explore LSS CSFs in other sectors or regions highlighting the gap in the knowledge and existing literature in understanding the extent of LSS application in the healthcare sector and factors that support its implementation to achieve better operational and hospital performance. Given the above, this study attempted to answer the following question: is there room to focus on healthcare to understand the impact of LSS CSFs on organisational performance?

Although there is a number of anecdotal papers examining the benefits of LSS, there are very few papers focusing on empirical and rigorous research on LSS's impact on organisational performance (Shafer & Moeller 2012). In the same vein, Aboelmaged (2010) concluded that there were very few LSS empirical studies after he conducted a literature review of 417 refereed journal articles. Hence, the need to empirically explore LSS research in this area is identified in an effort to expand the body of knowledge in terms of understanding how LSS works in new sectors and geographies.

Antony et al. (2018, p.20) in their comprehensive review of the literature that included 68 papers focusing on Six Sigma in healthcare came to this remarkable conclusion:

> '*The authors feel there is no roadmap in the current literature on the deployment of Six Sigma in a hospital setting and this could be an interesting topic for further research and would require empirical settings through action research. Moreover, a readiness assessment model would be very useful before hospitals embark on the journey of Six Sigma.*'

The conclusion above further supports the need for this study to focus on LSS implementation in UAE hospitals given there were very few studies in the UAE and no clear roadmap for implementation.

However, one must acknowledge the vast literature focusing on improving healthcare operations using CI initiatives (Arthur 2011; Dickson et al. 2009; Hagg et al. 2007; Kumar and Kwong 2011; Shiver and Eitel 2010; Yaduvanshi and Sharma 2017; Trakulsunti and Antony 2018; Graban and Swartz 2012). LSS is currently implemented to improve healthcare processes such as emergency, surgery, radiology, pathology, pharmacy and cardiology (Suman and Prajapati 2018). Hence this study focuses on one aspect of LSS - that is the extent of application and its impact on hospital performance.

As LSS implementation in Middle East countries and GCC is still in the early stages (Albliwi et al. 2017; Sreedharan and Raju 2016) a number of questions remain unanswered concerning the extent of LSS application in developing countries. Although it is clear that several studies have been proposed in other countries, the literature does not feature any studies investigating LSS impact on hospital performance in the UAE context. Hence, the healthcare sector in the UAE, as a developing country, provides another new dimension to explore.

Considering the literature advanced earlier, the author identified the following gaps:

1. There is a need to explore LSS CSFs in the UAE healthcare sector, given the specific nature of the transient workforce and healthcare complex hierarchical structure.
2. There is a need to investigate LSS success measured by the impact on hospitals performance in the UAE.
3. No other studies have investigated LSS CSFs clustering and sequencing in the UAE.
4. There is a need to design a deployment framework to guide successful LSS deployment in UAE hospitals.

Previous LSS CSFs studies assumed a stable workforce. However, early indications showed that this might not be the case in the UAE. Hence, the fundamental premise of this study was to empirically investigate LSS implementation in UAE hospitals and its impact on hospital performance. The contribution of this study was in examining the direct impact of LSS Strategic, Tactical and Operational CSFs on LSS implementation measured by hospital performance. Another contribution was the development of a framework to study LSS CSFs interdependencies.

2.16 Summary

The findings of this chapter can be summarised as follows: first, it presented an extensive literature review on quality evolution, TQM concepts and its ties to Six Sigma, Lean origins and its evolution based on the historical development of phenomenon leading to the fusion with Six Sigma to become LSS. It has been shown that while many of these quality initiatives share many similarities with regards to origin, approach and CSFs, they differ in some aspects, including the involvement of employees and approach structures. Second, it elaborated on the CSFs that can influence the success of LSS implementation. Third, it reviewed the literature on LSS healthcare and hospital performance measures. Fourth, it examined the research on TQM, Lean, Six Sigma, LSS impact on organisational and hospital performance.

The chapter concluded that these quality improvement initiatives originated in western and developed countries, especially in the manufacturing sector generating a research gap for this study to explore LSS in the healthcare sector in the UAE. Moreover, what has emerged from the overall discussion in the chapter is the fact that in order to implement LSS in healthcare in the UAE, it is necessary to understand the CSFs for implementation thoroughly, yet the literature does not present studies investigating LSS CSFs in the UAE healthcare context, nor the LSS impact on UAE hospital performance. This discussion created the foundation to conceptualise an LSS model for implementation and research question that will aim to fill the knowledge gap identified in the literature. In the next chapter, an attempt is made to develop a conceptual model for the implementation of LSS underlying the UAE healthcare context based on the Donabedian healthcare framework.

CHAPTER 3: LITERATURE SYNTHESIS AND DEVELOPMENT OF A CONCEPTUAL MODEL

3.1 Introduction

In Chapter 2, a review of TQM, Lean, Six Sigma and LSS was presented to gain a better understanding of the concepts. Discussions in Chapter 2 also revealed that there is a gap in terms of the application of LSS in healthcare (Albliwi et al. 2017; Shokri 2017; Antony et al. 2018; Sreedharan and Raju 2016). While previous research has focused on TQM in different industries including, there were few studies focusing on LSS CSFs, its impact on organisational performance and how the CSFs are clustered or sequenced to achieve the best results. The author was inspired by a number of papers (Salaheldin 2009; Alosani and Yusof 2018; Lamine and Lakhal 2018; Ali et al. 2016; Carmona-Márquez et al. 2016; Antony and Kumar 2012; Sabry 2014; Ali and Alolayyan 2013) proposing a new LSS model to be tested in UAE hospitals. The following sections present the development of this model.

3.2 Selection of CSFs for this study

The literature advanced in the previous chapter attempted to review and compile the CSFs needed for LSS implementation in organisations and the healthcare sector. The review included extracting the most common CSFs as identified by 21 key papers that are listed in the Table in Appendix A. The CSFs frequency was determined using Pareto analysis as shown in Figure 3.1 where the chart illustrates the most frequent CSFs in the literature according to researchers and practitioners. Reviewing the literature and considering the different arguments between the researchers and the importance of each factor, it was decided to choose CSFs that scored 7 occurrences following the 80/20 rule. As a result, 15 CSFs were identified, as shown in Table 3.1 and selected to develop the conceptual model. It is worth noting that the selected CSFs were similar to the CSFs identified in a global literature review conducted by Antony et al. (2018) on healthcare Six Sigma papers. The CSFs also aligned with the CSFs presented in a literature review by Sreedharan et al. (2018). This is an indication that LSS CSFs tend to be shared globally.

3.3 Description of CSFs selected for this study

The Table in Appendix B shows a detailed description of the 15 CSFs selected for this study. These descriptions served as the operational definitions that guided the selection of the questions in the questionnaire and the CSFs analysis in the coming chapters. These descriptions were based on a variety of sectors. These CSFs descriptions are universal and have been used by many researchers in many CSFs studies (Yadav and Desai 2016; Zhang, Irfan, Aamir, et al. 2012; Tyagi et al. 2016). It can be noticed that the CSFs are very similar for healthcare, manufacturing and service when it comes to LSS.

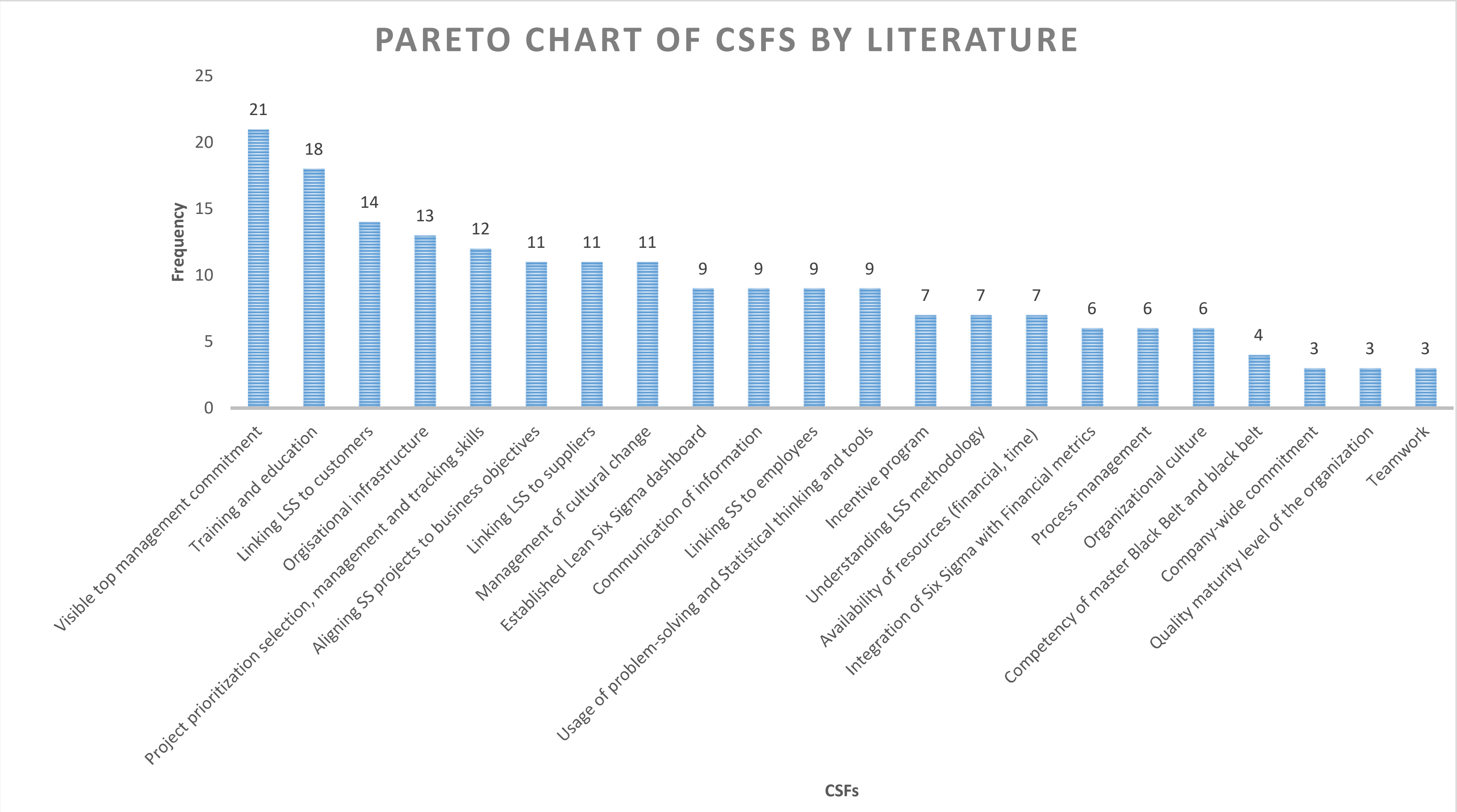


Figure 3.1: Pareto Analysis for CSFs
Source: Author

Table 3.1: CSF ranking and codes

Ranking	CSF code	Title
1	CSF5	Top Management Commitment
2	CSF13	Training and education
3	CSF6	Linking LSS to customers
4	CSF22	Organisational infrastructure
5	CSF10	Project prioritisation selection, management, and tracking skills
6	CSF1	Aligning LSS projects to business objectives
7	CSF7	Linking LSS to suppliers
8	CSF8	Management of cultural change
9	CSF14	Communication of information
10	CSF16	Linking LSS to employees
11	CSF18	Usage of problem-solving and Statistical thinking and tools
12	CSF3	Established LSS dashboard
13	CSF15	Incentive program
14	CSF17	Understanding LSS methodology
15	CSF19	Availability of resources (financial, time)

Source: Author

3.4 CSFs allocation to categories (themes)

It is argued that understanding how CSFs work together will enhance the success of LSS in organisations (Salaheldin 2009; Carmona-Márquez et al. 2016; Waters 2016). The author adopted the Strategic, Tactical and Operational classification, used by Salaheldin (2009), Carmona-Márquez et al. (2016) and Kader Ali et al. (2016), to categorise the 15 CSFs shown in Table 3.2. The author used the Strategic, Tactical and Operational definitions, as presented in section 2.10.1 to allocate the individual CSFs and develop the proposed model. Strategic factors or antecedents are required before the launch of an LSS programme. Examples of strategic factors are leadership, organisational culture, top management support, continuous improvement and benchmarking (Salaheldin 2009;

Carmona-Márquez et al. 2016). Tactical factors are needed to launch of LSS projects and engagement of the teams. Examples of tactical factors are team building, problem-solving tools usage, employee empowerment, employee involvement and employee training (Salaheldin 2009; Carmona-Márquez et al. 2016). While operational phase involves project initiation, building LSS project charters including the scope and problem statements and tracking and monitoring. Examples include process management, understanding LSS methodology, linking LSS projects to customer and suppliers, established LSS dashboard, project prioritisation and selection and project management skills (Salaheldin 2009; Carmona-Márquez et al. 2016). As mentioned in section 2.11.3, there is no consensus in the literature on the allocation of CSFs to categories and researchers assume different allocation based on the models explored. There is an apparent gap in the literature on how these CSFs are clustered and sequenced to achieve the best results. In this study, the author adopted the 3 themes (Strategic, Tactical and Operational) and allocated the CSFs to those themes by suggesting 3 different models, as shown in Figure 4.7, 4.8 and 4.9. It is worth mentioning that since this study is an exploratory study, the suggested allocation may change as a result of the PLS-SEM analysis.

Table 3.2: CSFs allocation to STO categories

Categories (Theme)	**CSF**	**Code**	**Reference**
Strategic – Antecedents required before LSS programme launch	Top Management Commitment	STMC	(Salaheldin 2009; Carmona-Márquez et al. 2016; Lamine and Lakhal 2018)
	Management of cultural change	SMCC	
	Aligning LSS projects to business objectives	SABO	
	Understanding LSS methodology	SULM	
	Communication of information	SCOI	
	Organisational infrastructure	SOIN	
	Availability of resources (financial, time)	SAOR	
Tactical- Factors needed prior to and during LSS projects initiation phase	Linking LSS to employees	TLLE	
	Incentive programme	TIPR	
	Training and education	TTED	
	Usage of problem-solving and Statistical thinking and tools	TUPS	
Operational- Factors needed at LSS	Established Lean Six Sigma dashboard	OESD	
	Linking LSS to suppliers	OLLS	

projects initiation, charters and day-to-day actions	Project Prioritisation selection, management, and tracking	OPPS	
	Linking LSS to customers	OLLC	

Source: Author

3.5 Selection of hospital performance measures for this study

After contrasting and reviewing different organisational, healthcare and hospitals performance measures advanced in section 2.10 chapter 2, and given the similarity of the scope of this study and the works of Sabry (2014), Khaidir et al. (2013), Shazali et al. (2013) and Ali and Alolayyan (2013), the author adopted Ali and Alolayyan's (2013) hospital performance measures and operationalised these measures as dependent variables using questions in the survey questionnaire.

The latent variables defined in Table 3.3 were used to operationalize the hospital performance measures given their simplicity to be used in the questionnaire. Operationalization means to convert an abstract concept into a manifest measurement. A latent variable represents a complex, multifaceted concept that cannot be operationalized using a single measure, but, according to measurement theory, must be operationalized using multiple inter-related measures (Allen and Yen 2002). The four latent variables were operationalized using a balanced approach of perspectives including customer/patient, internal business process, learning growth performance, and financial as discussed in section 2.9 (Kaplan and Norton 2005; NIST 2018). The four perspectives present an opportunity for organisations to report a balanced approach to measure performance (Habidin and Yusof 2012; Khaidir et al. 2013; Talib, Rahman and Azam 2011; Delić et al. 2017) as they measure 4 critical performance areas in a hospital namely: patient outcomes that will involve measuring patient satisfaction (usually conducted in surveys by hospitals or direct contact) and impact on reduction of lead time for hospitals operations (e.g. radiology reports, admissions, pharmacy). The staff and work system outcomes are concerned with employees satisfaction and turnover and if the implementation of LSS impacted their satisfaction. The hospital efficiency and effectiveness are addressing productivity (e.g. the impact on LSS on resources) and if defects and errors decreased as a result of LSS. The flexibility performance is concerned with the reduction of waste (non-value activities) and increase of hospital competitive profile which may lead to cost control and reduction and increased revenue or profits. In this study, hospital performance was measured by four latent variables and their assigned 8 measures that have the same weight.

Table 3.3: Hospital performance measures

Latent Variable	**Measures**	**Perspective**
Patient outcomes	HPAS: Patient satisfaction HSLT: Service lead time	Customer
Staff and work system outcomes	HEMS: Satisfaction HEMT: Turnover	Learning and Growth
Hospital efficiency and effectiveness outcomes	HPRI: Productivity increase HNSD: Number of service defects and errors decrease	Internal processes
Flexibility performance outcomes	HWAR: Waste reduction HICP: Increase in competitive profile	Financial

Source: Author. Adapted from (Ali and Alolayyan 2013; Kaplan and Norton 2005)

3.6 The proposed LSS model

As indicated in the previous chapter, the need to investigate the relationships between LSS CSFs and their impact on widely accepted indicators of hospital performance becomes essential. The conceptual model proposed for this study is based on the literature arguing that many organisations which implemented LSS benefited from the presence of CSFs (Deng et al. 2016; Jeyaraman et al. 2010; Albliwi et al. 2014; Abu Bakar et al. 2015; Ali et al. 2016). Consequently, the proposed conceptual model for this study seeks to examine the impact of three LSS CSFs themes on hospital performance. Figure 3.2 outlines the new conceptual model, proposed by the author. This model was developed from Donabedian framework in Figure 2.10 in which the Outcome dimension (i.e., the end results of healthcare practices) was replaced by Hospital Performance and the dimensions of Structure (i.e. how care is organised) and Process (i.e. what is done) were replaced by Strategic, Tactical, and Operational factors.

The detailed hypothesised relationships between the CSFs three themes and LSS successful implementation measured by hospital performance are presented in the next chapter.

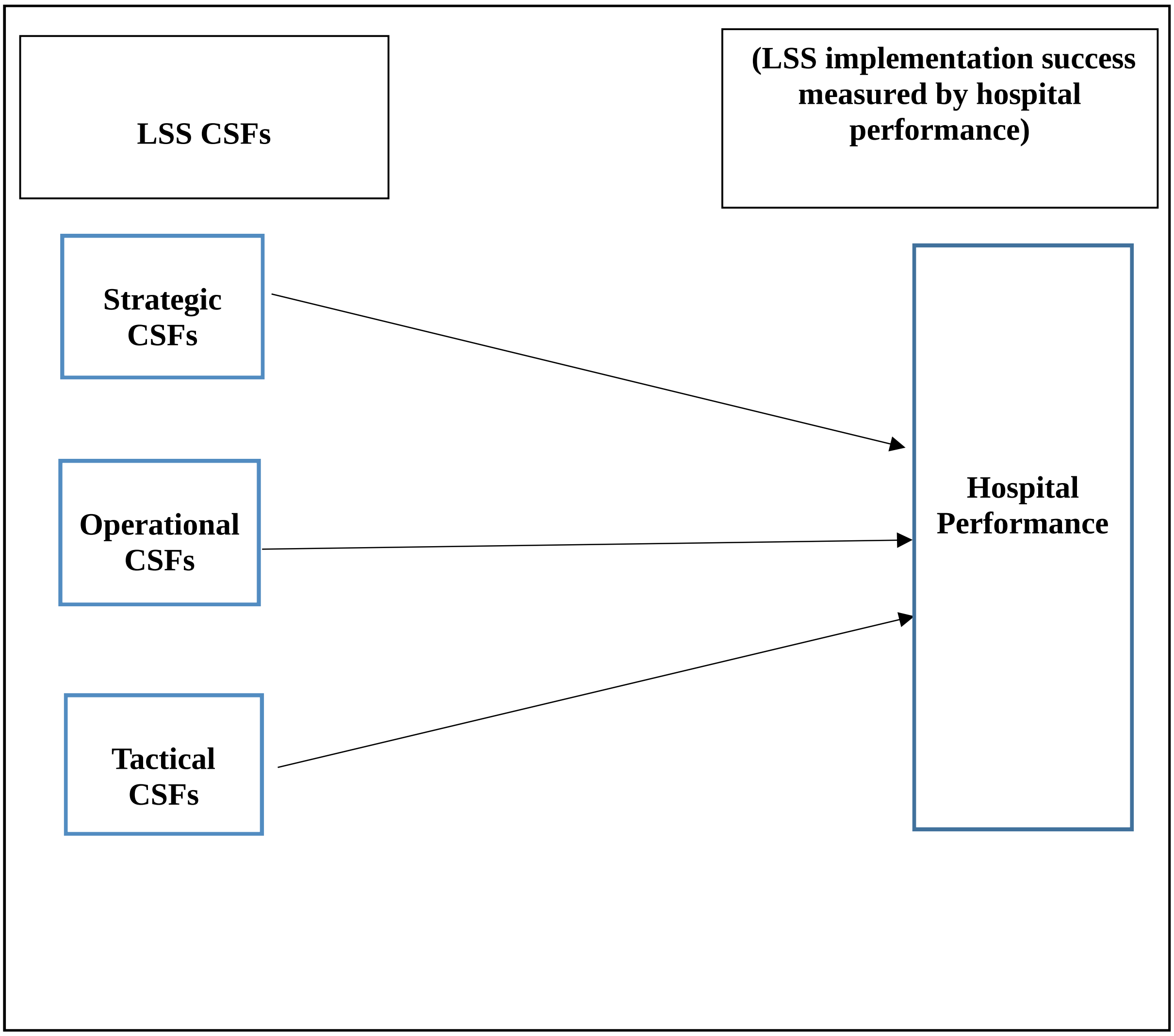


Figure 3.2: Conceptual model
Source: Author. Adapted from (Salaheldin 2009; Jeyaraman et al. 2010; Sabry 2014; Hilton et al. 2008; Laureani and Antony 2012; Lande et al. 2016; Wasage 2012; Waters 2016; Soti et al. 2010; Sweis et al. 2016; Shazali et al. 2013; Ali and Alolayyan 2013; Carmona-Márquez et al. 2016; Ali et al. 2016; Talib, Rahman and Azam 2011)

3.7 Summary

Although the Donabedian framework has acted as a primary foundation for the evaluation of the quality of healthcare organisations for over 50 years, it has been criticised for failing to incorporate precursor factors needed to evaluate the quality care as discussed in section 2.13.1. Many argue that successful LSS implementation in hospitals should ideally result in better outcomes for patients, including improved clinical processes, the elimination of waste from patient pathways, and increased quality, safety and efficiency that will have enhanced hospital performance indicators (Fillingham 2007; Jimmerson et al. 2005; Anbari and Kwak 2004; Radnor and Boaden 2008; Silvester et al. 2004; Manos et al. 2006; Antony et al. 2018). Hence, the author proposes a new model in order to overcome the Donabedian framework limitations based on the implementation of LSS and the required CSFs. The proposed model has been developed by (a) re-defining Donabedian’s Outcome dimension in terms of successful implementation of LSS (indicated by Hospital Performance) and (b) by using Strategic, Tactical, and Operational CSFs themes to replace Donabedian’s Structure and Process dimensions.

Chapter 4 presents the research design and methodology and provides more detailed information for defining the selected dimensions and operationalizing the variables that constitute the proposed model. Chapter 4 also describes how the validity of the proposed LSS model will be tested by the quantitative analysis method (PLS-SEM).

CHAPTER 4: RESEARCH DESIGN AND METHODOLOGY

4.1 Introduction

Methodology refers to the stance of a researcher towards explaining and understanding phenomena in the real world (Bernard 2013). Chapter 4 presents details of the study's underlying philosophy, describes and justifies the methodology chosen to achieve the aims and objectives of this mixed-methods study. To that end, this chapter discusses and justifies the research aims and objectives, the research design, the research philosophy, the research strategy, the survey tools, and data collection procedures. Underpinned by the conceptual model outlined in Chapter 3, details concerning how the variables were selected and the data analysis techniques, including the quantitative PLS-SEM approach and the qualitative ISM approach, are provided. Finally, the ethical considerations and the limitations of the study are presented.

4.2 Research aim, questions and objectives

The overall aim of this research was:

> *To examine whether the STO CSFs are positively correlated with LSS successful implementation in UAE hospitals measured by hospital performance.*

4.2.1 Research question

The above aim was achieved by providing defensible quantitative and/or qualitative evidence, in order to facilitate the provision of answers to the following research question (RQ):

> *To what extent are the STO CSFs positively correlated with LSS successful implementation in UAE hospitals measured by hospital performance?*

The research question investigated the correlations between LSS STO CSFs themes and LSS successful implementation. The correlations were assumed to be positive because the Donabedian model (Donabedian 2002) predicts an improvement in the quality of its outcomes if the structures of health care facilities including processes are improved as illustrated in Figure 3.1.

4.2.2 Objectives

To address the study aim, the study sought to achieve the following objectives:

1. To examine the extent to which LSS is implemented in UAE hospitals.
2. To identify the significant LSS CSFs and allocate them to their STO themes in UAE hospitals to develop a conceptual model.
3. To evaluate the correlations between STO CSFs and LSS successful implementation measured by UAE hospital performance.
4. To develop a framework for LSS deployment in UAE hospitals (LSSDFH) clarifying the interdependencies between the CSFs.

The next sections will elaborate on the different research paradigms setting the scene to select the study paradigm, methodology and methods.

4.3 Research design

After identifying the research aim and objectives, a research design must be crafted to describe the specific steps through which the research will be executed (Saunders et al. 2009). It should provide the justification for the selected methods and the logical plans to collect and analyse data to arrive at the conclusions and findings (Yin 2014).

A research design clarifies the philosophy, approach, time horizon, choices and strategies. This was explained by Saunders et al. (2009) in his model 'The research process onion'. The choice of the research paradigm, methodologies and methods will depend on the type of research questions researched but also can be influenced by the researcher background and personal training and experience (Creswell 2013).

Figure 4.1 outlines how the introduction, literature review, and conceptual model presented in Chapters 1, 2, and 3, subsequently led to the chosen research design, based on a mixed-methods approach, including descriptive statistics, the qualitative and quantitative analysis described later in this chapter.

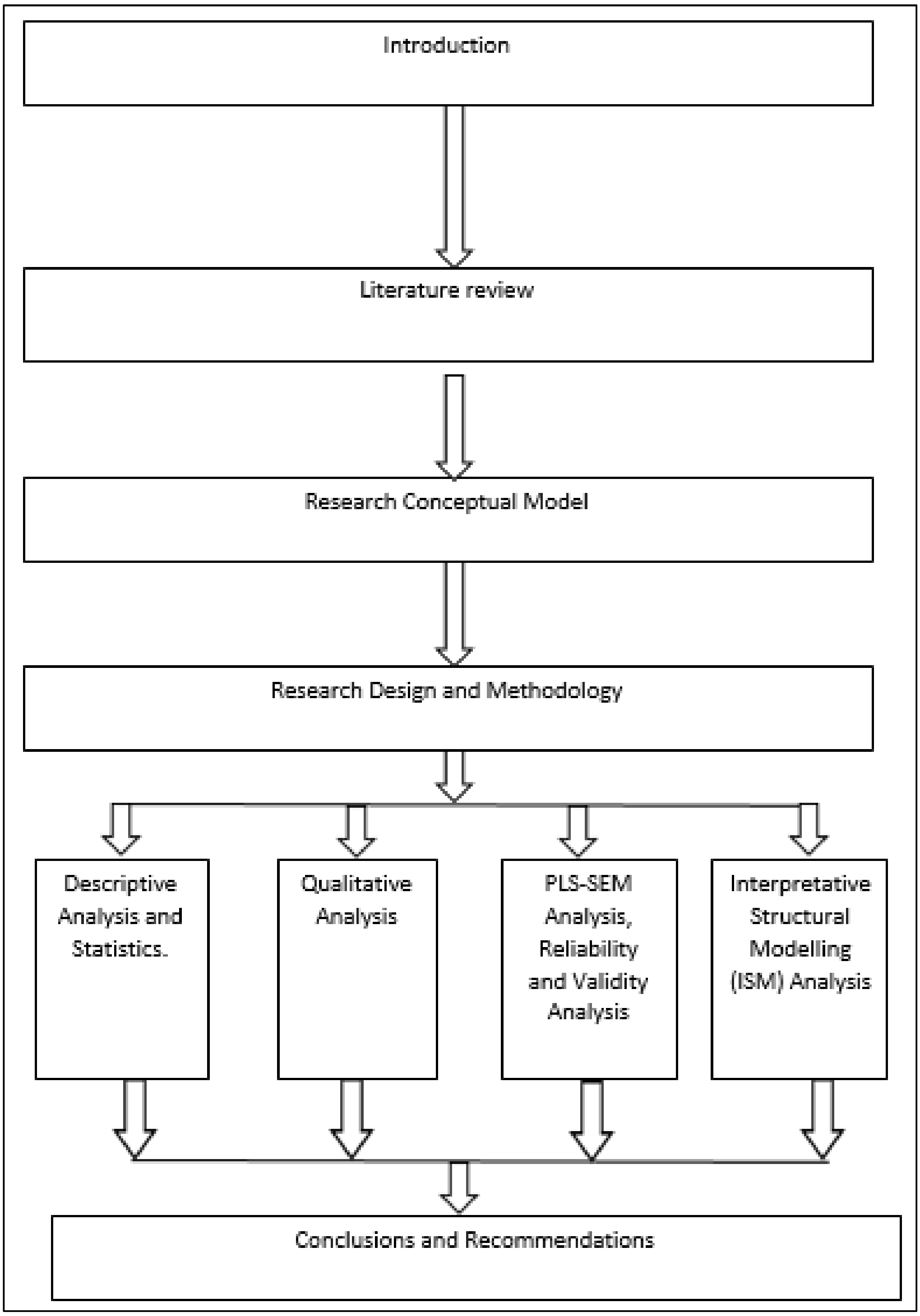


Figure 4.1: Development of the research design
Source: Author

The research design starts with the selection of a research paradigm that leads to the selection of the appropriate methodology, methods and data collection approaches. The next section will discuss the available research paradigms and the justification of the choices for the selected paradigm, methodology and methods.

4.4 Research philosophy and paradigms

The way that researchers think and plan for the development of knowledge is research philosophy (Saunders et al. 2009). Research philosophy is a paradigm or worldview, made up of general theoretical assumptions and laws, and techniques for their application that the members of a particular scientific community choose to adopt (Guba 1990). Every researcher must look through a philosophical lens in order to obtain a perspective that guides his or her research. Creswell (2013) identified three major paradigms (Shown in Table 4.1) held by social scientists, termed Post-positivism, Constructivism, and Pragmatism. Paradigm refers to the researcher’s approach on how to conduct research (Collis and Hussey 2003). Guba and Lincoln (1994, p.107) define a paradigm as ‘basic belief systems based on ontological, epistemological, and methodological assumptions’. While Bryman (2015, p.630) defines a paradigm as a cluster of beliefs and dictates which guide researchers to choose their research, how research is conducted, and how results should be interpreted.

Moreover, upon embarking on research, the researcher usually should articulate the ontology and epistemology. According to Guba and Lincoln (1994), ontology is the study of reality and whether the researcher sees the world as objective or subjective. Researchers view epistemology as a way to understand things and how do we know something while they view the methodology as the ‘how’ to go about finding out about whatever the researcher believes is known (Crotty 1998). A more detailed guide on oncology, epistemology, paradigm, methodology and methods is shown in Figure 4.2. Consequently, the research design will heavily depend on the selected ontology and the researcher paradigm stance.

In general, researchers have two distinct choices for paradigms by which to conduct their research: positivist or phenomenology also referred to as quantitative or qualitative approaches (Collis and Hussey 2003). Collis and Hussey (2003) defined phenomenology as the science of phenomena. In the 1990s a new paradigm emerged, as an explicit rejection of the forced choice between post-positivism and constructivism that allowed researchers to the use mixed approaches in their methods to collect and analyse data (Armitage 2007; Creswell 2013). The use of a mixed-methods approach, or a pluralistic approach, emerged as a new paradigm called the pragmatic paradigm (Creswell 2013).

4.4.1 Pragmatism

The dichotomy of research paradigms outlined above implies that quantitative and qualitative methodologies associated respectively with positivism and social constructivism, are incommensurable. Pragmatism, otherwise known as constructive realism (Cupchik 2001) is advantageous because it requires pluralistic philosophies when a mixed-methods approach is considered to be the most appropriate, involving a mixture of quantitative and qualitative methodologies. Pragmatism may be viewed as a ‘radical departure from age-old philosophical arguments about the nature of reality and possibility of truth’ (Morgan 2014, p.5).

Furthermore, a pragmatist would focus on the characteristics of both post-positivism and constructivism approach to inquiry instead of assigning one of the approaches a priori to various ontological and epistemological areas (Morgan 2014). However, pragmatism has its challenges. One challenge in adopting the pragmatist perspective is the need to integrate the qualitative and quantitative data in order to generate a coherent theory (Almalki 2016; Bryman 2006; Bryman 2007).

As a result of the discussion advanced earlier, and at a philosophical level, the author chose to adopt a pragmatic paradigm using Mixed Methods Research (MMR) due to a number of reasons that will be presented in the next section.

Table 4.1: The three dominant research paradigms

Methodology	*Post-positivism*	*Social Constructivism*	*Pragmatism*
	Quantitative	**Qualitative**	**Mixed Methods**
Reality	**Single reality (Outside the human mind)**	**Multiple realities (Socially constructed)**	**Both single and multiple realities**
Viewpoint	**Impartial**	**Not impartial**	**Practical**
Bias	**Unbiased**	**Biased**	**Multiple stances (biased and unbiased)**
Interpretation of data	**Deductive, or "top-down" starting with theory, then using data to test the theory**	**Inductive or "bottom-up", starting with data, then using data to generate theory.**	**Pluralistic, involving deductive and inductive approaches**
Presentation of data	**Formal**	**Informal and literary**	**Both formal and informal**
Outcomes	**Counts and Measurements (implying causes and effects).**	**Understanding**	**Counts and measurements (problem-centred, oriented towards the real world)**

Source : Author. Adapted from (Creswell 2013)

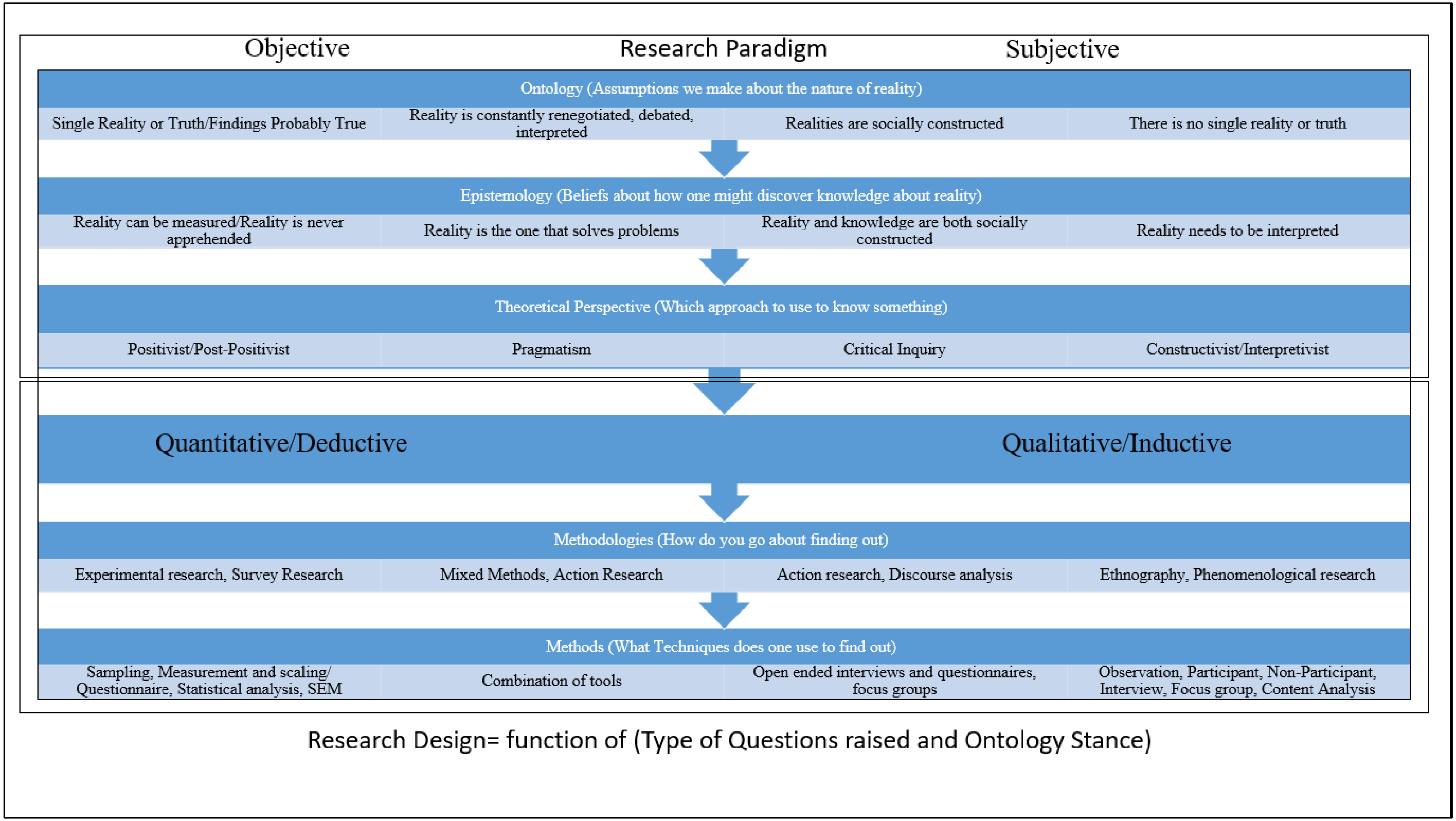


Figure 4.2: Guide to developing research
Source: Author. Adapted from (Crotty 1998; Creswell 2013; Guba and Lincoln 1994; Symon and Cassell 2012)

4.5 The chosen research paradigm

The justification for using MMR approach in this study was that answering the research questions requires a pragmatic approach, offering broader philosophies and methodologies than using either Post-positivism or Constructivism/ Interpretivism, alone could provide.

Consequently, this study employed a quantitative approach using cross-sectional surveys supported by a qualitative approach using semi-structured interviews in data collection to test the proposed model. Tashakkori & Teddlie (2010) argued that there are three reasons why one may consider MMR superior to mono-methods approach. First, MMR can answer research questions that other approaches cannot; MMR can address simultaneously confirmatory and exploratory questions. Second, MMR has the ability to provide stronger inferences to answer complex social issues. Third, MMR provides an opportunity to use divergent findings from different vantage points.

The following reasons are cited for the choice of the pragmatic approach and MMR in this study:

- The research nature investigating the research questions mandated the need for an MMR. More specifically, the question ‘To what extent the STO CSFs are positively correlated with LSS successful implementation in UAE hospitals measured by hospital performance?’ is addressed using an inductive quantitative approach, using PLS-SEM, to test the proposed hypotheses.
- The objective ‘To develop a framework for LSS deployment in UAE hospitals clarifying the interdependencies between the CSFs’ is addressed using a qualitative deductive approach, using ISM, to extract more specific details about the possibility of causal relationships that could not be obtained using a quantitative method alone.
- The research aim, objectives and the research questions presented earlier required a mix of quantitative and qualitative approaches, as shown in Table 4.2.
- The dependence on quantitative and qualitative methods for collecting and analysing the data mandated the use of mixed methods.

- Many researchers have used MMR in similar studies to some degree of success (Noori 2015; Antony and Banuelas 2002; Hajikordestani 2010; Jeyaraman et al. 2010; Sweis et al. 2016; Albliwi 2017)

Moreover, pragmatism focuses on both deductive and inductive logic in generating theory. Consequently, pragmatism was considered appropriate for this study because the modelling technique (PLS-SEM and ISM) utilised surveys, statistical data analysis and expert groups brainstorming. Figure 4.3 illustrates the overall methodological approach adopted for the study represented by the 'research onion' (Saunders et al. 2009, p.109). The next section will discuss both quantitative and qualitative methodologies and the pros and cons of each.

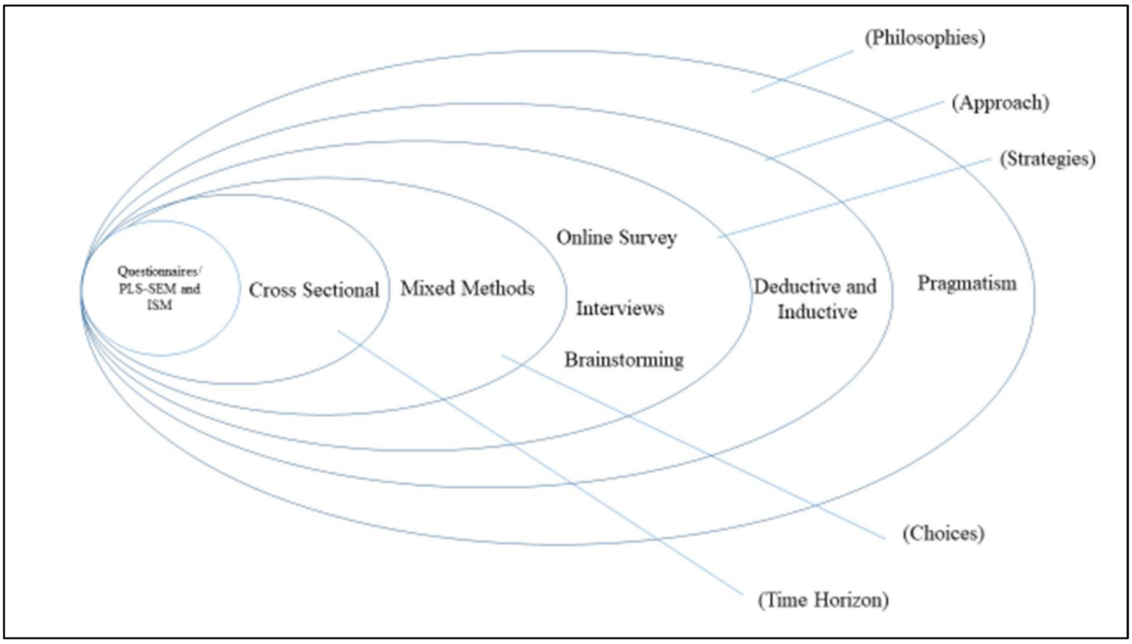


Figure 4.3: The study research onion
Source: Modified by Author. Adapted from (Saunders et al. 2009, p.108)

4.6 The chosen methodology, methods and justification

The two terms, methodology and methods words are (incorrectly) used interchangeably in research. They include statistical analysis, surveys, content analysis, etc. according to Carr (2006), the methodology is the theoretical rationale or principles that will guide and justify the choice of the research methods. Further, Carr argued that the methodology has to be grounded in that form of a *priori* theoretical knowledge referred to as the 'philosophy'. It can be argued that there is no one ideal methodology that will fit all situations when conducting research. The selection of the methodology and methods will depend on a number of variables, including the type of research question and the objectives.

As mentioned earlier, methods refer to data collection tools used in the research process and hence questionnaires, focus group, interview and observation are examples of these methods. While data can be collected using various methods and from multiple sources, attention should be given to obtaining reliable data. Therefore, to answer the research questions, a systematic orientation must be in place to guide the data collection and data analysis (Saunders et al. 2009; Bryman 2015). Each method has its advantages and disadvantages. The following sections present and compare the main types of methods.

4.6.1 Quantitative and qualitative research methods

Quantitative research methods are concerned with the empirical testing of proposed models or hypothesis and are generally associated with the positivism or post-positivist paradigm (Saunders et al. 2009). On the other hand, qualitative research methods are concerned with the social process and with the interaction between the researcher and the people or the situation being studied (Saunders et al. 2009). Qualitative research is rooted in the phenomenological paradigm that seeks to explore the social world and analyse the culture and behaviour of humans and their groups from the subjects' viewpoint (Bryman 2015). Its primary aim is to explore and understand the meaning that individuals present to a social or human problem (Creswell 2013). The approach is inductive in nature and seeks to make interpretations of the meaning of the data.

Both qualitative and quantitative methods are valid in research. However, a number of distinctions exist between them (Saunders et al. 2009, p.482). First, the quantitative method generates meaning from numbers, while the qualitative focus on meaning extracted from words. Second, collection results are usually in numerical and standardised data, while the qualitative approach will result in non-standardised data requiring classification into categories. That may present subjectivity while classifying data. Third, quantitative analysis is conducted through diagrams and statistics, while qualitative analysis is conducted through the use of conceptualisation.

The adopted methodology for this study is based on MMR approach but with a quantitative emphasis (QUAN+qual) where the focus is on the quantitative element (Tashakkori and Teddlie 2010; Johnson and Onwuegbuzie 2004). The chosen methodology allowed the author to address the objectives advanced earlier, guided by the choice of the paradigm.

4.7 Research strategy

A research strategy is defined as a systematic orientation that allows for data to be collected and analysed using reliable methods in an attempt to answer research questions (Bryman 2015; Saunders et al. 2009). The study research strategy, shown in Figure 1.1, was designed to answer the research questions and was directly aligned to the research objectives, as illustrated in Table 4.2.

Table 4.2: Alignment of research objectives to methodology and methods

Research Objectives	Research Methodology	Research Methods	Analysis Method
1. To examine the extent to which LSS is implemented in UAE hospitals.	Quantitative Qualitative	Survey & Interviews	Descriptive
2. To identify the significant LSS CSFs and allocate them to their STO themes in UAE hospitals to develop a conceptual model.	Quantitative Qualitative	Literature review, Survey and Interviews	Descriptive
3. To evaluate the correlations between STO CSFs and LSS successful implementation measured by UAE hospital performance.	Quantitative	Survey	PLS-SEM
4. To develop a framework for LSS deployment in UAE hospitals (LSSDFH) clarifying the interdependencies between the CSFs	Qualitative	Group Brainstorming	ISM

Source: Author

4.8 Data collection

A number of data collection methods were used in the study using quantitative and qualitative approaches. This section will clarify each of these methods and the rationale for selecting them.

4.8.1 Data collection methods

As a result of applying the aforementioned philosophy and methodology, several different quantitative and qualitative research methods could be selected to collect and analyse data (Creswell 2013). There are a number of data collection techniques that researchers can use. These include a review of documentary sources, case studies, interviews, questionnaire surveys, experiments and observation. In this study, the type and nature of the research questions and the central hypotheses mandated a methodology and methods to accommodate both quantitative and qualitative analysis. The research tools used in this study included (a) a self-administered online survey using questionnaires; (b) semi-structured interviews; and (c) brainstorming. The following sections will clarify the used methods, justification and limitations.

4.8.2 Survey

Surveys are usually used in empirical research to collect views and opinions of respondents from a large sample (Saunders et al. 2009; Zikmund 2003). Surveys can be conducted in various ways. They include face-to-face surveys, telephone surveys or self-administrated mail or online surveys (Collis and Hussey 2003). In a survey, the way a questionnaire is structured and designed is critical to allow the accurate collection of data to facilitate the exploration and investigation of the relationships between the study variables. Hence, if the survey is conducted in the correct manner, then the results from the sample group may be generalised to a larger group. Furthermore, the design and distribution of a questionnaire can impact the response rate and consequently, the validity of the results. This study utilised a self-administrated online questionnaire survey to collect data with an aim to explore the research questions in more depth by utilizing descriptive and statistical methods to analyse data.

4.8.3 Self-administered online survey

Questionnaires are used as part of the survey's research to collect information on research questions (Saunders et al. 2009). Moreover, questionnaires are considered one of the most popular tools to collect data from a large sample through questions to generate data that can be used for descriptive and quantitative analysis. The literature review indicated that many researchers used questionnaires successfully to collect data in similar studies exploring TQM, Lean and Six Sigma (Antony et al. 2005; Douglas et al. 2015; Laureani and Antony 2012; Achanga et al. 2006; Jeyaraman et al. 2010; Albliwi et al. 2017; Ali and Alolayyan 2013; Tran 2006; Hilton et al. 2008; Dubey et al. 2016; Kuvvetli et al. 2016).

There are different types of questionnaires. The two main types are self-administrated and interviewer-administrated (Saunders et al. 2009). Figure 4.4 further illustrates the common types of questionnaires considered by researchers (Saunders et al. 2009). The author chose to use a self-administered questionnaire.

There are a number of advantages to using a self-administrated questionnaire to collect data. First, since the amount of contact time when using a questionnaire survey affects data collection, the questionnaire allows respondents ample time to fill the survey at their convenience and hence this may improve the response rate (Saunders et al. 2009). Second, questionnaires are a quick and cost-effective means of collecting data; however, response rates could be low unless the respondents are engaged (Sapsford and Jupp 2006; Bryman 2015). Additionally, the author's personal knowledge of many quality and LSS professionals in the healthcare sector in the UAE and the fact that email contact details for some quality managers and LSS GB and BBs in healthcare were readily available were incentives to use an online self-administrated questionnaire. However, there are a number of disadvantages for using questionnaire surveys, as illustrated in Table 4.3. The actions made by the author to mitigate these disadvantages are also shown in Table 4.3 and will be clarified in the next sections.

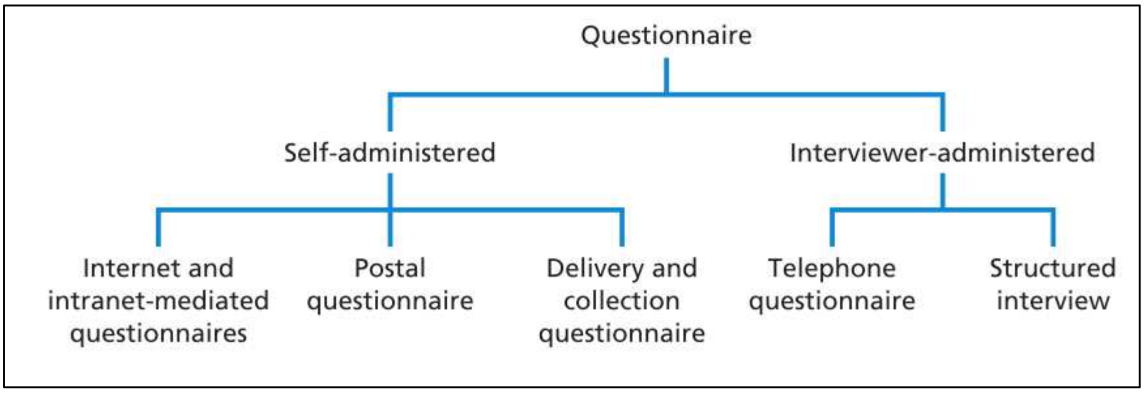


Figure 4.4: Questionnaire types
Source: (Saunders et al. 2009, p.363)

Table 4.3: Questionnaire survey advantages and disadvantages

Advantages	Disadvantages	Author mitigation measures
Cheaper than interviews and useful if respondents are in diverse geography	May yield a low response rate	The author will use his personal contacts and Linkedin groups to increase response rates. Will use Bi-weekly reminders Will call respondents to encourage participation
Guarantees anonymity for respondents	Hard to control who is filling out the questionnaire	NA
Minimizes interviews bias	Hard to check the accuracy of data filled	Will use multiple techniques in questionnaire design(See next sections)
Respondents are given ample time to check his or her records	Hard to check in-depth information as the questionnaire tend to have simple questions	Will use semi-structured interviews to explore

Source : Author. Adapted from (Collis and Hussey 2003; Nachmias and Nachmias 1996)

4.8.4 Questionnaire design and questions type

It is critical to define and select the type of questionnaire questions very accurately to ensure error-free data collection since there is only one chance to collect data from respondents and researchers may not have another chance to collect further data.

Bourque and Clark (1994) suggested three approaches to design questionnaires: First, adopting them from a previous study questionnaire that has been tested and standardised. Second, adapting them from previous questionnaires and modifying them. Third, adopting and adapting the research questions to be more suitable to the research context while maintaining reliability. The author followed the third approach, where he approached a number of researchers to obtain copies of questionnaires used in similar peer-reviewed studies published in the fields of TQM, Lean, Six Sigma or LSS. Based on these questionnaires and other similar questionnaires available in the literature, the survey questions were derived and adapted to measure CSFs and hospital performance.

In questionnaires, researchers can use three types of data variables for the questions (Dillman 2011). They are opinion, behaviour and attribute (descriptive). Naturally, the type of data to be collected will mandate the type of statements and questions wording. Opinion questions relate to the respondent's feelings and perceptions about the issue investigated. Behaviour questions relate to the actions and experiences of the issues explored while attributes or descriptive questions relate to collecting attribute data such as demographic variables. There are a number of research questions types that can be used by researchers. They include open-ended, closed-ended, list, category, ranking, rating, quantity and matrix (Saunders et al. 2009).

In terms of selecting the rating scale for the questions in this study questionnaire's sections two, three and four , the author opted to use the Likert scale. Likert scale was developed by Rensis Likert, where respondents are invited to express their degree of agreement or disagreement over a scale offering range from one extreme attitude to the other. The Likert scale can vary from four to seven choices, as shown in Table 4.4. Likert rating scales with an uneven number of choices that allow respondents to endorse a middle or neutral option (e.g., score = 3 in a 5-point scale, or score = 4 in a 7-point scale) were initially designed over 50 years ago for use in marketing surveys. The Likert scale was designed to elicit consumers' views about whether or not they agreed, or did not agree, to endorse or purchase a specific product in the marketplace.

Using the Likert scale simplifies coding but also presents the risk of acquiescence bias where respondents may agree with all statements without considering the true meaning of the statements (Watson 1992; Smith 2004; Bryman 2015). There is much research evidence to demonstrate that some respondents tend to consistently respond "agree" to all of the items in a questionnaire irrespective of whether or not they actually agree in reality causing the results of the statistical analysis to be biased and none of the results is significant. If most of the responses are clustered around one option (e.g. 'Agree') then there is a little variance in the data, so the correlation coefficients are attenuated (i.e., misleadingly low) and the conclusions are meaningless. For example, if a 5-point rating scale containing only two levels of agreement (i.e. 4 = Agree or 5 = Strongly Agree) is used, then there is a tendency for many respondents to consistently choose 4 = Agree for all or most of the items, regardless of the items' content, and irrespective of whether or not the respondents agree to the items, in reality, creating the acquiescent response bias.

From an analysis point of view, if the distribution of the response data in a 5-point scale is skewed or clustered around one or two points (e.g. 3 = Neutral, or 4 = Agree) then the statistical analysis of this data generates biased results. The mean scores (i.e., 3 or 4) are biased estimates of central tendency, the variances and correlations computed from the biased scores are attenuated and estimates of internal consistency reliability are inaccurate (Agresti 2010).

Another disadvantage could be that the scale is unidimensional and presents only 4 to 7 choices where each choice cannot possibly be equidistant and may fail to measure the actual attitudes of respondents. Moreover, respondents may be affected by previous answers and may concentrate on one side of the scale. This can be attributed to the fact that respondents generally avoid selecting the extremes even if the correct answer is (LaMarca 2011). Additionally, there is much research evidence, however, to indicate that providing respondents with middle options in item scales designed to elicit opinions about personal, social, and organizational issues may generate biased results (Choi and Pak 2005; Paulhus 1991; Saris et al. 2010; Sedgwick 2013). Experiments have shown that many of the respondents who consistently choose the middle options in survey item would otherwise agree or disagree with the items if no middle options were available (Bishop 1987).

The use of continuous 6-point item scales measured at the interval level without middle options facilitates the computation of unbiased measures of central tendency, including the mean scores, accurate to one decimal point (Carifio and Perla 2008). However, the mean item scores were not relevant in this study because a non-parametric method (PLS-SEM) is used to address the research questions and test the hypotheses. In PLS-SEM, the latent variables or constructs are not operationalized using mean item scores but are operationalized using mathematical models that represent exact linear combinations of the item scores (Hair et al. 2017). In this study survey, when respondents were asked to express opinions about the implementation of LSS and hospital performance, the inclusion of middle options in 5 or 7 point item scales may just provided an easy solution for recalcitrant respondents who do not like to express stronger opinions, or who do not want to expend a lot of time and effort deciding whether or not to agree or disagree with the items. Another type of bias can be present when having response format with vague options such as ‘not sure’; ‘do not know’; ‘neither agree nor disagree’; ‘not applicable’;

‘neutral’ or any other option that allows the respondent to provide an unmeasurable response. Consequently, respondents may choose a vague or neutral option (Gwinner 2011; Dolnicar et al. 2011; Cummins and Gullone 2000; Garland 1991).

Considering the discussion advanced earlier and previous questionnaire rating scales, the author selected a 6-point Likert scale to avoid the acquiescent response bias. Consequently, the following scale was selected in questionnaire section two: 1 = Strongly disagree; 2 = Moderately disagree; 3 = Mildly disagree; 4 = Mildly agree, 5 = Moderately agree, and 6 = Strongly agree. Section three questions also used a 6-point Likert scale. The scale was as follows: 1 = Never; 2 = Seldom; 3 = Sometimes; 4 = Frequently; 5 = All the time; 6 = Not applicable. Given the nature of questions in section four, a 5-point Likert scale was appropriate. The scale was as follows: 1 = Not very important; 2 = Not important; 3 = Important; 4 = Very important, 5 = Critical. The choice of these types of questions makes it easy for the respondents to answer and for the author to analyse significant differences (Collis and Hussey 2003). Moreover, Dawes (2008) showed that the use of item rating scales with more than 6 points does not improve the validity or reliability of the response data, and therefore a 6-point scale was acceptable for the current survey. Furthermore, the use of a 6-point continuous scale to measure each item in the current survey will avoid the item scores being biased by the respondents consistently choosing either the middle or the ‘Agree’ options.

In summary, the author has opted not to use a neutral (middle) and vague responses in the Likert scale and adopted the continuous 6-point Likert scale in some parts of the questionnaire as used by some researchers (Wasage 2012; Wasage 2016; Noori 2015).

Table 4.4: Response categories for rating questions

Type of rating	Five categories	Seven categories
Agreement	Strongly agree Agree Neither agree nor disagree/not sure/uncertain* Disagree Strongly disagree	Strongly agree Agree/moderately agree/mostly agree* Slightly agree Neither agree nor disagree/not sure/uncertain* Slightly disagree Disagree/moderately disagree/mostly disagree* Strongly disagree
Amount	Far too much/nearly all/very large* Too much/more than half/large* About right/about half/some* Too little/less than half/small* Far too little/almost none/not at all*	Far too much/nearly all/very large* Too much/more than half/large* Slightly too much/quite large* About right/about half/some* Slightly too little/quite small* Too little/less than half/small* Far too little/almost none/not at all*
Frequency	All the time/always* Frequently/very often/most of the time* Sometimes/about as often as not/about half the time* Rarely/seldom/less than half the time* Never/practically never*	All the time/always* Almost all the time/almost always* Frequently/very often/most of the time* Sometimes/about as often as not/about half the time* Seldom Almost never/practically never* Never/not at all*
Likelihood	Very Good Reasonable Slight/bit* None/not at all*	Extremely Very Moderately Quite/reasonable* Somewhat Slight/bit* None/not at all*

Source: (Saunders et al. 2009, p.380)

4.8.5 Surveys measuring respondents' perception

Many researchers have successfully used the Likert-style rating scale to investigate TQM and LSS CSFs in organisations and their impact on organisations performance where respondents choose their level of agreement with the statements (perception). The use of perceptual data has been used and accepted by many researchers in the fields of quality, LSS and healthcare (Sabry 2014; Zakuan et al. 2010; Albliwi et al. 2017; Prajogo and Sohal 2003; Ali and Alolayyan 2013; Ali et al. 2016; Iyede et al. 2018). For example, Das et al. (2000) and Samson and Terziovski (1999) used self-reported feedback from respondents on performance, product quality, customer satisfaction, employee morale, productivity and delivery performance.

The author decided to adopt previous studies approach that have used perception data to evaluate patient satisfaction based on the perception of the quality and LSS practitioners working at UAE hospitals who will be most likely familiar with their hospital measures including patient satisfaction scores and the impact of LSS, if any, on these scores. Obtaining patients satisfaction scores was not be possible and useful in this study for the following reasons: (a) many private and governmental UAE hospitals are reluctant to share patient satisfaction data and (b) it would not be accurate to link generic aggregated patient satisfaction scores to LSS implementation as the improvement in scores could be due to other factors (e.g. more delightful lobby or faster Wifi). Furthermore, many medical and healthcare researchers argue that data derived from surveys of the perceptions of patients provide distorted, misleading, and biased results (Barrett and Schriger 2015; Broadwater-Hollifield et al. 2014; Patwardhan and Leadersh 2012; Sedgwick 2013; Tyser et al. 2016; Jha et al. 2008).

Similarly, the productivity measure is answered through the following perception question: 'Since the implementation of LSS projects, did some of your operations improve with no increase in resources?' A productivity measure is related to the usage of resources and can be measured by the ratio of a measure of total outputs to a measure of inputs used in the production of goods and services. Hospitals may run LSS projects to reduce Turn Around Time (TAT) or improve operating room efficiency to improve productivity (Bhat et al. 2014; Tagge et al. 2017). Hospital Quality and LSS practitioners would be knowledgeable about such projects.

The variables in Table 3.2 and 3.3 guided the development of the survey questions (shown in Appendix C). The questions with the Likert scales measured perceptions of hospital quality and LSS practitioners rather than the patients themselves. However, it can be argued that the perceptual Likert scale approach does not measure actual performance in any way and self-reporting data may have a potential bias; therefore, introduces a high degree of measurement error into the data. As a result, the author has conducted a number of semi-structured interviews to validate the results of the main survey.

4.8.6 Questionnaire outline

Researchers argued that to assess the current status and the extent of LSS application in an organisation, a number of issues need to be explored (Albliwi et al. 2017; Chakrabarty et al. 2007; Antony and Desai 2009; Antony and Banuelas 2002; Alsmadi et al. 2012; Ali and Alolayyan 2013). These issues include the following and have been considered during the questionnaire design in alignment with the research questions:

1. Importance and ranking of CSFs for LSS
2. Years of deploying Lean, Six Sigma or LSS
3. Other moderators such as size, type of organisation, other quality programmes or accreditation status
4. Impact of LSS on organisational performance

Since the author selected an explanatory approach as one of the research vehicles for this study, the questionnaire was designed to capture data about demographic details (e.g. hospital location, hospital size in terms of number of beds, number of employees, type of hospital, JCI status, ISO 9001 status, respondent job position). Moreover, the questionnaire was designed to explore the respondents' perception or opinions concerning LSS CSFs, the degree of LSS implementation and impact on hospital performance. Original questions and statements relating to each of the CSFs and hospital performance measures were extracted from similar studies, as shown in Appendix C.

Based on the above discussion, a mix of opinion, descriptive, closed-ended, open-ended, list and ranking questions was used in designing the study questionnaire. The survey utilised a descriptive style with closed-ended questions to collect background information and multiple-choice questions (opinion) with 1-6 and 1-5 Likert scales. Table 4.5

illustrates the various question types used in this study and the purpose of each questionnaire section.

Table 4.5: Questionnaire outline

Section #	Section	Purpose	Question structure
1	Demographic LSS extent of application	To filter hospitals according to specific variables and collect data about moderators To investigate the extent that Lean, Six Sigma or LSS initiatives are employed.	Closed-ended, multiple choice questions
2	CSFs	To measure CSFs impact on the success of LSS and define the level of CSF application	Closed-ended, Likert scale: 1-6
3	Hospital Performance Measures	To measure the hospital performance as a result of LSS deployment	Closed-ended, Likert scale: 1-6
4	CSFs Ranking	To rank the importance of extracted CSFs from the perspective of respondents and to reveal if there are other CSFs specific to healthcare	Closed-ended, Likert scale: 1-5; Open-ended.
5	Optional Data	To ask respondents if they want to record their name, email, hospital name and if they want to participate in the semi-structured interview.	Open-ended

Source: Author

4.8.6.1 Questionnaire layout and enhancing response rate

An important issue that may face researchers when using self-administrated online questionnaires is the low response rate, which may create bias in results if the sample is too small (Lemon 2007; Frohlich 2002). The response rate is defined as the number of completed questionnaires divided by eligible sample members (Frohlich 2002). Response rates are related to response times that are affected by the number and type of answer categories, and the location of the question within the questionnaire (Yan and Tourangeau 2008). In the field of operations management, the suggested response rate is between 20-40 per cent (Frohlich 2002) while Forza (2002) suggested 50 per cent as a minimum. Other LSS researchers suggested that 10 per cent may be acceptable when using the questionnaire approach since LSS is an advanced methodology that may not be well known in developing countries such as the UAE (Albliwi et al. 2017). To improve the response rate in this study, the author used the following techniques suggested by Frohlich (2002). The first technique is ‘leverage design’ where the author asked his contacts at hospitals and DHA, SEHA and HAAD to forward the questionnaire link to hospital quality and LSS professionals on his behalf. The second technique is ‘multiple emails’ where the author sent reminders in an interval of 2 weeks for 6 weeks after the first questionnaire was sent. The third technique is ‘steady pressure’ where follow up calls were made by the author to his contacts to remind them to fill and forward the questionnaire to the target sample. The fourth technique is ‘subject interest’ where the author used the available databases for quality and LSS professionals at hospitals.

It can be argued that a questionnaire layout affects the response rate. Additionally, lengthy surveys can cause respondents what is called ‘response fatigue’ (Galesic and Bosnjak 2009). In their study, the researchers manipulated the stated length (10, 20, and 30 minutes) and the position of questions in an online questionnaire and concluded that the longer the stated length, the fewer respondents started and completed the questionnaire. Hence the author made every effort that the questionnaire does not take more than 10-15 minutes to fill. Additionally, the study questions were kept to a reasonable length, number and appropriate locations within the questionnaire layout based on feedback obtained during the validation phase. For example, the author decided to reduce the number of questions measuring each CSF to one. The single-item measure is accepted as a trade-off between over-surveying, that may lead to low response rate, and predictive validity in research (Diamantopoulos et al. 2012).

Moreover, Tourangeau and Yan (2007) recommended that sensitive questions are placed at the end of a survey. In this study, questions on hospital performance , LSS performance and hospital name can be considered sensitive questions. Hence these questions were placed towards the later sections of the questionnaire. In terms of response layout, Dillman (2011) suggested that responses should be presented in a straight line and using the same order of response categories to avoid confusion.

The questionnaire was validated by a panel of experts and pre-tested using a pilot study to ensure that those questions are clear and well laid-out. This will be explained in more details in the following sections.

4.8.6.2 Response bias

There are a large number of reasons why it is not possible to validate questionnaire response data. Response bias (i.e., the unconscious or deliberate distortion of the truth) is a significant cause of lack of validity. Choi & Pak (2005) identified a total of 48 sources of bias in the responses to self-report questionnaires. On average, about 10 to 15% of responses to questionnaires could be biased.

Choi & Pak (2005) identified three primary sources of bias in questionnaires. The first could be from the way a question is designed. The second could be from the way the questionnaire as a whole is designed. The third could be from how the questionnaire is administered. The first and second sources were addressed in this study by conducting an expert validation exercise. The administration of the questionnaire could also lead to some bias. The areas of bias could come from the respondent's subconscious reaction, which may create end aversion (central tendency). Additionally, bias could come from what is called 'faking good' or 'social desirability' (Choi and Pak 2005). Social desirability refers to the tendency of some individuals to answer self-report instruments falsely in such a way as to over-report or exaggerate desirable issues, whilst under-reporting or evading undesirable issues (Van de Mortel 2008). There is evidence to suggest that the stereotypical cultural communication style of some Arab respondents may result in biased answers to certain types of questionnaire items and interview questions (Baron-Epel et al. 2010; Harzing 2006; Minkov 2009; Smith 2004). Cultural response bias occurs when the respondents' answers are embedded in the organizational norms, values, and beliefs of their own cultures. Hence, it is likely that some of the respondents will not respond truthfully to all of the items in the questionnaire, and this issue will also cause the results to be biased, and possibly meaningless.

To address the above potential biases, a number of researchers suggested some techniques to identify these biases in order to remove suspect answers. For example, Saunders et al. (2009) proposed the use of both positive and negative statements in the questionnaire to identify any acquiescent issues and to ensure accurate response by respondents (i.e.

attention trap questions). Other researchers suggested adding questions from the social desirability scale to the questionnaire to measure the extent of socially desirable responding (Ballard 1992).

Other researchers suggested the use of bogus statements or questions at multiple points throughout the questionnaire to help identify respondents that have not answered the questionnaire truthfully. Bogus items may include ridiculous statements or other items to which all of the respondents if they are answering truthfully, should adequately respond with “Strongly disagree”. Examples of bogus statements are: there are no outpatients in the hospital, there are no inpatients in the hospital, the hospital does not provide any type of specialized healthcare or services, or none of the hospital employees has the correct qualifications to do their jobs. If any respondents are answering carelessly or randomly, or are not adequately reading any of the questions, but just answering mindlessly, then they will not honestly respond with “Strongly disagree” It is possible that several respondents are expected to agree to some or all of the bogus questions in a survey (Lavrakas 2018). Because their responses are not trustworthy, all of the data provided by these respondents must be excluded from the survey, to avoid collecting meaningless results.

Based on the above discussion the author decided to use a question from the social desirability scale in Appendix D in the pilot study questionnaire to measure the extent of this bias, however since the pilot study results did not reveal a bias from the socially desirable question, the author decided to remove this question from the main study to avoid confusion. The author also decided to use the following bogus question in the main questionnaire section 2: ‘Lean Six Sigma has absolutely nothing to do with healthcare management.’ Responses to this question with other than ‘Strongly disagree’ or ‘ disagree’ were removed. Additionally, the author reversed the scale on two questions in section 2 to measure the respondent's attentiveness and truthfulness.

4.8.6.3 Questionnaire content validity

The study questionnaire is considered to have content validity as its measurement items are adopted from previous peer-reviewed studies and dissertations. Moreover, the questionnaire was reviewed by a panel of experts. This content validation approach is widely used and accepted by researchers (Kimberlin and Winterstein 2008; Al-Shammari

2013; Habidin et al. 2016; Jeyaraman et al. 2010). The objective was to reveal and address possible ambiguities and biases in the wording of questions and other layout issues. Two channels were used to obtain feedback on the questionnaire.

The first channel involved conducting a workshop to review the questionnaire design by a number of consulting and academic researchers experienced in market research and questionnaire design. To make the most of the time in the workshop, the author sent the questionnaire by email prior to the workshop, and the participants were asked to review, fill the questionnaire and record their comments in preparation for the workshop. An evaluation guidance sheet was also sent with the questionnaire (Attached in Appendix E). The experts were asked to provide their views on questions wording, questionnaire length, the sequence of questions and any weaknesses they observe. After which they were invited to attend a 1-hour session to discuss their recommendations. The workshop was conducted at the author's organisation offices. During the workshop, participants were asked to provide detailed feedback on the overall design, particularly the measurement scales and the overall clarity of the questions and statements. They were also asked to provide feedback on the questionnaire layout, and if the time to fill out the questionnaire was reasonable. For the first channel, the group consisted of five academic researchers and consultants who were chosen based on their experience in research, conducting market analysis and questionnaire design. Each participant had a minimum of 10 years' experience in research and consulting, and four participants held Doctorate degrees and were familiar with research principles.

In the second channel, a number of quality and LSS experts and researchers were emailed the questionnaire and asked to provide their views on questions wording, clarity, questionnaire length, the sequence of questions and appropriateness to the healthcare environment. Seven responses were received and were used to modify the questionnaire. The criteria used to select the LSS experts was their experience in quality, TQM, Lean, Six Sigma and LSS either as practitioners (GB or BBs or Master BBs) or as academics with publications in quality, TQM, Lean, Six Sigma and LSS field.

Additionally, the author used the verbal protocol analysis technique (Bolton 1991). Protocols are similar to an interview where respondents are asked to take the questionnaire and indicate verbally to the researcher issues relating to the questionnaire

(Diamantopoulos et al. 1994). This type of observation helps to identify issues with defective questions, unclear and questions logic. The author observed two academic/researcher colleagues and obtained their feedback on the questionnaire filling process in terms of appropriate vocabulary, order of questions, skip patterns, timing, and interest, attention and respondent well-being.

As a result, feedback from the two validation channels was summarised, and questions endorsed by the experts (Shown in Appendix F) were retained, and items that were deemed unclear were modified or removed (Detailed feedback received, and actions can be found in Appendix G). Moreover, the survey questions were discussed with leading LSS and quality professionals during the seventh Lean Six Sigma International conference held in Dubai in May 2018 organised and chaired by Professor Jiju Antony, one of the leading researchers on the topic of LSS.

In light of the feedback from the two channels, the final draft questionnaire was updated and piloted with 15 LSS practitioners in the field of healthcare. The next chapter will describe the process of the pilot study and the results.

4.9 The final study questionnaire

Based on the above discussions, the author designed the survey questionnaire to be not overly complicated and to be clear. Some question statements previously used in the field by LSS and TQM researchers were directly used, while some of the question statements were modified to fit with the healthcare industry. After considering the feedback from the panel of experts, the final questionnaire was in 8 pages in English. In its final format, the study questionnaire was designed to consist of 5 parts. The first part of the questionnaire collected information about hospital type, size (in terms of beds and number of employees), hospital location, the status of quality programmes or accreditation, areas of LSS implementation and the extent of LSS deployment. The second part of the questionnaire focused on collecting information related to LSS CSFs application. The third part included questions on the perception of the results of LSS deployment in terms of hospital performance.The fourth part focused on CSFs ranking and importance, where respondents were asked to rank CSFs and add any other CSFs. In the fifth part, there were questions about the respondent's perception of LSS future at their hospitals and if the respondents would like to participate in a semi-structured interview, participate in the raffle and receive a copy of the aggregate results. The Table in Appendix C shows the battery of questions used to generate questions for the CSFs and hospital performance sections. The final questionnaire used for the main study is attached in Appendix H.

The email sent with the questionnaire link included a brief introduction to the study objectives with instructions to respondents. The respondents were given a choice to stop the questionnaire at the beginning or during the process. The respondents were asked to relate to their LSS implementation experience at their hospital.

4.9.1 Interviews

Interviews were used as part of this mixed-methods study to enhance the study's reliability and validity. Interviews are typically part of the qualitative methodology and are essential to collect empirical data (Yin 2014; Bryman 2015). Interviews have a number of advantages as they allow the interviewer to control the situation better, explore and clarify the answers and enhance response rates compared to survey questions (Merriam and Tisdell 2014). Interviews are preferred when the questions are open-ended and complex (Collis and Hussey 2003). Furthermore, using interviews can help to gather valid and reliable data to support the main study findings and calibrate results (Saunders et al. 2009).

Three types of interviews can be used in qualitative research: (a) structured; (b) semi-structured and (c) unstructured (Yin 2014). Questions in a structured interview are asked in the same sequence of the questionnaire and followed in each interview. This style is fast and objective. The unstructured interview uses more open questions but is less objective and may take a long time while semi-structured interviews use both open-ended and closed-ended questions. The author selected the semi-structured interviews method for this study, as this type can provide explanations of why things happened (Creswell 2013). The open-ended questions used in the interview questionnaire were designed to explore issues related to the study objectives and the factors incorporated in the questionnaire survey. The interviews were conducted by the author. The author is an experienced quality and strategy consultant/auditor who has considerable interviewing experience.

A number of limitations which may threaten the validity of the findings must be considered when conducting research using questionnaires and interviews. Interviews can be time-consuming, expensive and may introduce reactance from the interviewers' side, and the results cannot be generalised (Yin 2009; Bryman 2015). A further limitation of this study was the possibility of author bias. His personal viewpoint could potentially lead him to focus on specific aspects of the data more than others. In order to avoid bias, and to ensure the validity of the findings, the author was self-critical and adhered to the ethics code obtained and approved by the university.

4.9.2 Brainstorming

The brainstorming technique is used with a group of LSS of experts at the final stage of the study to conduct the ISM. Brainstorming is a group engagement tool to obtain qualitative feedback and to generate ideas for further discussion (Tague 2005). A brainstorming session was conducted with nine LSS experts to design the ISM model (Warfield 1973) and to generate the LSSDFH. The process is further explained in the ISM section (4.12.6).

4.10 Population and sampling

There are multiple sampling strategies that can be used by researchers. The selection of the strategy will impact the generalisability of the results; hence identifying the target population and a representative sample becomes critical (Collis and Hussey 2003). Among these strategies are probabilistic sampling methods (e.g. simple random sampling, stratified random sampling, systematic random sampling and cluster sampling) or non-probabilistic sampling methods (e.g. convenience sampling, quota sampling, purposive sampling and snowball sampling) (Saunders et al. 2009; Zikmund 2003).

4.10.1 Population

According to Churchill (2010), a population is the totality of cases in the sample that conform to previously specified design parameters. The population in this study will be the quality department staff and LSS team members in UAE hospitals (i.e. those with detailed knowledge of Lean and Six Sigma methodology and its impact on their hospitals). There were 119 hospitals in the UAE at the time of the study (The U.S.-U.A.E. Business Council 2014; Emiratesdiary 2015; HAAD 2016).

As the author could not locate an authoritative database of the population of the quality department staff and LSS team members at all UAE hospitals, the author used a number of lists and databases to source the sample contacts. The databases sources came from the database at Meirc Training & Consulting (employer of the author), UAE industry lists (Dubai Healthcare Authority (DHA), Abu Dhabi Health Services Company (SEHA), Health Ministry of UAE), healthcare quality LinkedIn relevant groups (e.g. LSS for Hospitals, Lean, Six Sigma & Process Excellence in Healthcare, Healthcare Professionals in MENA, GCC Healthcare Network, Abu Dhabi Quality Forum (ADQF), Middle East Quality & Improvement Professionals, Lean, Six Sigma & Process Excellence in Healthcare, LSS War Room, ASQ UAE and Lean Six Sigma) and the author's personal database consisting of quality and LSS professionals who participated in previous quality and LSS training sessions and projects. Based on the above lists, a comprehensive sorting exercise was undertaken that identified 665 entries for the main survey sample representing governmental and private hospitals in the UAE. The list included 401 names (quality department staff and LSS Sigma team members) with emails and phone numbers, 145 Linkedin contacts and 119 hospital-wide emails. When using the hospital-wide emails, the questionnaire link was addressed to the quality manager. Hence the purposive sampling was used based on the judgment of the author to identify the individuals that are proficient and well informed of LSS implementation and its potential impact on hospital performance which fits the purpose of the study (Tashakkori and Teddlie 2010). This technique is appropriate when it difficult to specify a sample frame (Etikan et al. 2016)

4.10.2 Unit of Analysis

In this study, the unit of analysis was the UAE hospitals. However, since a hospital can not answer a survey, quality and LSS professionals in hospitals were selected to answer the survey questions as they were expected to have the knowledge of the subject of interest and to know the internal CI initiatives. In summary, the non-probabilistic purposive sampling technique was used to identify the respondents who were LSS practitioners (Master BBs, BBs, GBs) and quality managers whose unit of analysis was UAE hospitals.

4.10.3 Sample size

In a study, the research sample size can affect the statistical significance of the test statistic used to assess the relationships between variables (Saunders et al. 2009). Many researchers regard 100 respondents as the minimum sample size when the population is large while small sample size studies can yield indifferent statistical tests (Bryman 2015) However, in many studies the sample size is determined by two factors: the nature of data analysis methods proposed and the estimated response rate.

There are two methods to determine if a given sample size will provide accurate and precise quantitative results to make statements about a population. The first method is to conduct a sample size calculation, based on known population size, the required margin of error, and the required confidence level, using the formulae described by Omair (2014) for healthcare studies. However, since the population size is unknown in this study, this method was not applicable. The second method is to conduct a power analysis to determine if the sample size is large enough to provide sufficient power to identify statistically significant relationships between the variables. Statistical power ranges from 0 to 1. As statistical power increases, the probability of making a Type II error in a statistical test (i.e., falsely declaring the result to be not significant, when in fact, it should be significant). The statistical power of 0.8 is conventionally considered to be adequate for most statistical tests used in medical research Wong (2013) presented the results of power analysis to determine the absolute minimum sample size to conduct PLS-SEM with SmartPLS software based on the maximum number of latent variables pointing into a latent variable, assuming a conventional level of statistical significance (0.05); an adequate level of statistical power (0.8) and a moderate effect size ($R^2 = 0.25$, meaning that 25% of the variance in the data was explained by the structural model). In this study, a maximum of 7 predictor variables is pointing into hospital performance. (i.e., Strategic Factors, Operational Factors, Tactical Factors, and the four control variables which are assumed to be moderators: hospital JCI accreditation status; hospital size; hospital type: governmental or private; and hospital ISO 9001 certification status). Table 4.6 shows that the absolute minimum required sample size based on this power calculation is 80. Wong (2013) noted that although PLS-SEM is well known for its capability of handling small sample sizes, it does not mean that the goal should be to fulfil the minimum sample size requirement and suggested a sample size of 100 to 200 as a good starting point.

Table 4.6: Minimum sample size required for PLS-SEM

Minimum sample size required	Maximum # of arrows pointing at a latent variable in the model
52	2
59	3
65	4
70	5
75	6
80	7
84	8
88	9
91	10

Source: (Wong 2013)

Other authors presented more detailed results of power analysis for PLS-SEM. For example, Hair et al. (2017) reported the results of power analysis using the following parameters: statistical significance level = .05; power = 0.8, number of exogenous variables pointing into an endogenous variable = 2 to 10, and four effect sizes (R squared = 0.10, 0.25, 0.50, and 0.75). The required minimum sample sizes computed by power analysis corresponding to each of these four effect sizes in a model with 7 variables pointing into one endogenous variable were n = 166, 80, 51, and 41 respectively (Kock and Hadaya 2018).

In this study, the usable sample size of 97 respondents for hospitals who are implementing LSS provided adequate statistical power (0.8) to detect statistically significance path coefficients ($p < .05$) between the CSFs and Hospital Performance using PLS-SEM assuming a moderate effect size (R squared = 0.25). The moderate effect size was assumed to indicate practical significance, implying that the results of the PLS-SEM were meaningful, with applied implications in the context of healthcare research (Ferguson 2009; Ialongo 2016).

4.11 Survey response rate

Another issue to consider is that the response rate to surveys is generally very low. Nulty (2008) reported that on average, only 33% of people who are sent an online questionnaire would answer and return all of the questions. While Baruch et al. (2008) reported that the average response rate for studies that utilized data collected from organizations was 35.7%. The next chapter presents the results of the data collection and the response rate.

4.12 Data collection

4.12.1 Survey

Primary data collection was conducted via an online questionnaire survey, managed and administrated using the SurveyMonkey platform. Utilising the selected contacts list, the author sent introduction email with the survey link requesting the cooperation of the respondents to fill the survey and to forward the email to their quality and LSS colleagues at their hospitals or other hospitals.

The following approaches were used to enhance the response rate:

- The author utilised the snowball sampling technique (Often called chain-referral sampling), a technique used to identify quality and LSS practitioners in hospitals through the acquaintances of existing study objects (Zikmund 2003; Saunders et al. 2009).
- The author reached out to influencers in various hospitals (Human resources staff and management in hospitals) urging them to send the survey to quality and LSS practitioners.
- The author approached ASQ and LSS/ healthcare LinkedIn professional groups in the UAE requesting their assistance to post the study objectives and survey link on their social media groups.
- The survey was open for 12 weeks. Bi-weekly follow-up reminders were sent and posted on social media.

Details of the survey results are presented in Chapter 5.

4.12.2 Semi-Structured interviews

Participants were purposefully chosen as they indicated their desire to be part of the interviews in the survey provided they meet the following criteria:

- The interviewee works in a hospital implementing/has implemented Lean, Six Sigma or LSS.
- The interviewee works in a key quality managerial position and is familiar with quality implementation and LSS.

The Table in Appendix I presents the details of the 8 interviewees selected from 7 UAE hospitals, each with more than 10 years' experience in quality and LSS with LSS BBs or GBs qualification. Consequently, the interviewees had the desire to participate and had good experience and knowledge of their hospital quality management structure and improvement methodologies such as LSS to answer the interview questions.

4.12.3 ISM session

Nine participants, selected using purposive sampling, participated in the 5-hour session. Participants were chosen based on the following criteria: (a) has a minimum of 10 years' experience in quality and LSS and (b) has Six Sigma GB or BB qualification. The author decided to have a mix of participants to enhance group discussions and create productive debate. Four participants were chosen from healthcare and 4 from other sectors. The lead and decision power were given to healthcare participants. Hence, the participants were suitable for the ISM workshop and were capable of identifying the inter-dependencies between the CSFs (Jayant et al. 2014; Soti et al. 2010; Attri et al. 2013).

4.12.4 Interviewing process

Interviewees were sent an introduction email explaining the objectives of the study and the interview process. At the start of each interview, the author requested permission to record the interview and confirmed that all information provided would be for academic use only, and would remain confidential. This permission was granted by all interviewees. Bryman (2015) stressed that the interviewer should not be distracted during the interview and recording could help the interviewer focus more on the interview itself. Recording an interview is useful for the analysis and allows the interviewer to focus on the questions during the interview and takes the burden off to take notes thus helping the interviewer focus on the interview points (such as keeping to time schedules, questioning where necessary, and drawing attention to any inconsistencies in the interviewee's answers).

A pilot interview was conducted with one of the quality directors in a Dubai based hospital. After which, the author listened to the recording and updated the interview questions template to address flow and to incorporate some additional points according to the supervisor's feedback. Existing quality initiatives and accreditation, LSS extent of application, LSS factors, barriers and hospital performance indicators were considered as discussion points for the interviews. Questions were designed to solicit information concerning the tactics and techniques employed in the hospital with regards to LSS implementation process. While the interviewing process followed the guide in Appendix J, the author used probing questions when needed to follow up on topics that were of interest during the interview.

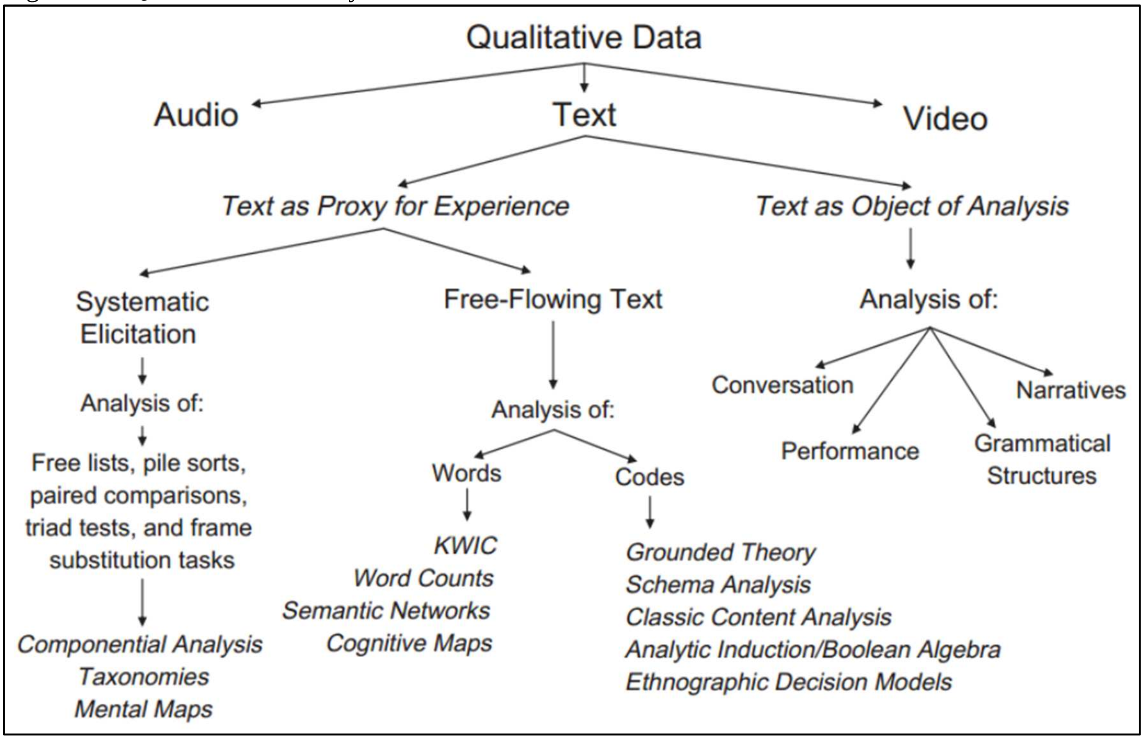
All interviews were conducted in English as it is the working language in most UAE hospitals (With some Arabic tick words that came up during the interviews). Six interviews were conducted on-site, and 2 were conducted in a nearby café. At the beginning of each interview, the author opened by thanking the interviewee for his/her time and explained the background of the study (research topic, aim and objectives). The interviewee was then asked a number of questions related to LSS deployment. Interviewees were encouraged to comment in the context of their experience and were given the opportunity to discuss additional issues with regards to LSS implementation. Below is a summary of the interview process.

- The author was well welcomed, showing interest from the part of the interviewees. The author started by explaining the purpose, anticipated duration, getting permission to record and transcribe responses as well as encouraging the interviewee to ask if a question was not clear.
- All interviews were recorded using a phone voice recorder. Some written notes were also taken.
- The author showed the interviewee how to stop recording and asked her/ him to stop recording whenever she/ he feels uncomfortable.

4.12.5 Interviews analysis

Bernard and Ryan (1998) outlined a useful typology to study and analyse qualitative data, as shown in Figure 4.5. In their model, data are divided into three basic types: text, images, and sound. Text analysis, which is very common in many social sciences, will be used in this study. The free-flowing text approach was followed to organise and present the data focusing on the analysis of words, themes and codes (Bernard et al. 2016). The interview findings were analysed in two ways: First, there is the content analysis of the themes; and secondly, there are extracts from the interviews to support the findings. The Free-Flowing text allows researchers to analyse words and codes hence creating common themes and word clouds.

Figure 4.5: Qualitative data analysis



Source: (Bernard and Ryan 1998, p.771)

4.12.6 Interviews Themes

The author adopted a thematic analysis for the data obtained from the interviews (Braun and Clarke 2006). Thematic analysis is defined as 'a method for identifying, analysing and reporting patterns (themes) within data' (Braun and Clarke 2006, p.79). A theme captures a critical aspect of the research questions. The process suggested by Braun and Clarke (2006) has been adopted by the author, as shown in Table 4.7. This type of analysis results in a logical and organised of the issues investigated in the study.

Table 4.7: Phases of thematic analysis

Phase	Description of the process
1. Familiarizing yourself with your data:	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2. Generating initial codes:	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes:	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes:	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.
5. Defining and naming themes:	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the report:	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

Source: (Braun and Clarke 2006, p.87)

Using the help of Otter mobile and web application, the author transcribed the recordings, which as noted by Bryman (2015) is a time-consuming process, taking professional transcribers between five to six hours to transcribe one hour of speech. In this study, it took approximately 2-3 hours to edit and finalise each interview transcript into a text document. Once the transcribed files were ready, the interviews were analysed identifying particular themes. Details of the interviews are presented in Chapter 8.

4.12.7 Interpretive Structural Modelling (ISM)

The study's fourth objective (*To develop a framework for LSS deployment in UAE hospitals clarifying the interdependencies between the CSFs)*) sought to explore the causal relationship between LSS CSFs. The author selected the ISM methodology to explore CSFs relationships.

ISM methodology, developed in the 1970s, is conducted in this study to identify the CSFs causal relationships and propose a theoretical framework (Sage 1977; Warfield 1973). ISM is a methodology, used by many scholars, for developing a framework based on hypothesized causal relationships among the various elements of a system related to a complex management issue (Attri et al. 2013; Jayant et al. 2014; Talib, Rahman and Qureshi 2011; Talib and Rahman 2015; Yadav and Desai 2017; Kumar et al. 2016; Alidrisi 2014). ISM is used to establish a structure where its main function becomes the organisation of elements. Its process involves organising a set of a set of different directly and indirectly related elements are structured into a comprehensive systematic model (Attri et al. 2013). The ISM process aims to impose order and direction by transforming a poorly defined concept into a well-defined model by explaining the structure of a management issue using graphics and words. Although ISM can be conducted by a single individual, ISM is primarily intended as a group learning process. Figure 4.6 outlines the ISM procedure.

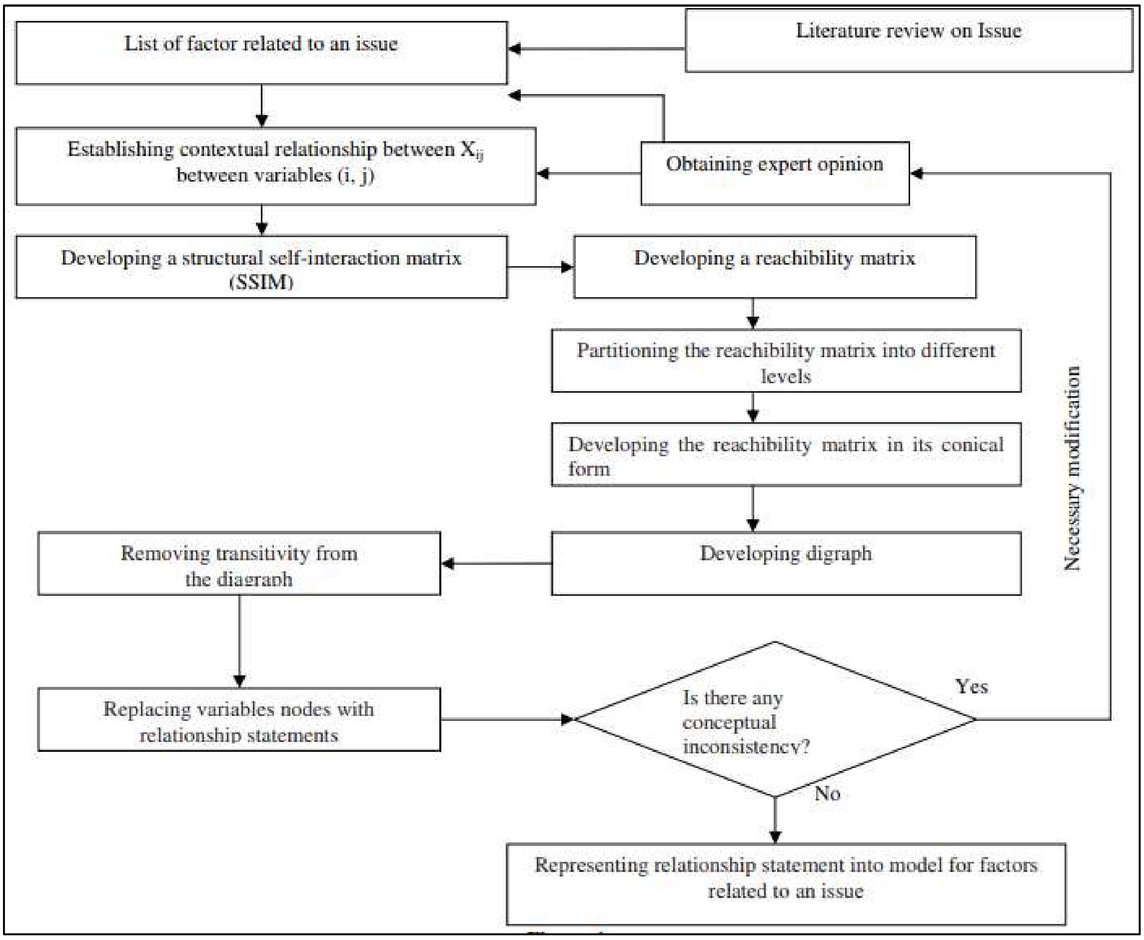


Figure 4.6: Flow diagram of ISM procedure
Source (Attri et al. 2013, p.4)

The detailed steps followed in this study ISM chapter are as follows (Attri et al. 2013):

Step 1: The 15 identified CSFs through the extensive literature review, as discussed in chapter 2 were included in the ISM exercise. At the outset of the brainstorming session, a 20- minute introduction was made by the author to explain the research objectives, session agenda and the CSFs proposed for the ISM exercise.

Step 2: A structural self-interaction matrix (SSIM) was developed using group discussions. The SSIM is based on hypothesized relationships, assuming that the variance in one variable leads to or influences the variance in another variable. The contextual relationship between pairs of variables are defined and symbolized as follows: i = one variable; j = other variable; V (i ,j) = i will influence j; A (i, j) = i will be influenced by j; X(i, j) = i and j will influence each other; O (i,j) = no relationship between i and j.

After the brainstorming session during which the various issues related to LSS implementation and the CSFs were discussed, a populated SSIM form was completed.

Step 3: The SSIM was converted into a binary matrix called the initial reachability matrix (RM) by substituting the four symbols (i.e., V, A, X or O) of SSIM by 1s or 0 (zero) in the initial reachability matrix. (a) If the (i, j) entry in the SSIM is V, then the (i, j) entry in the reachability matrix becomes 1, and the (j, i) entry becomes zero. (b) If the (i, j) entry in the SSIM is A, then the (i, j) entry in the matrix becomes zero, and the (j, i) entry becomes 1. (c) If the (i, j) entry in the SSIM is X, then the (i, j) entry in the matrix becomes 1 and the (j, i) entry also becomes 1. (d) If the (i, j) entry in the SSIM is O, then the (i, j) entry in the matrix becomes zero and the (j, i) entry also becomes zero.

Step 4: Once the initial reachability matrix has been developed, it is further verified for transitivity. According to the transitivity rule, if 'i leads to j' and 'j leads to k' then 'i will also lead to k'. This ensures the concurrency between expert opinions. After employing the transitivity rule, the initial RM is then modified.

Step 5: The RM is partitioned into different levels, based on a hierarchy. The lowest level of the hierarchy consists of variables that cannot be influenced by other variables but are able to influence the variables in the next upper level directly. This next upper level consists of variables that can be influenced by the variables at the lowest level, as well as influence the variables at the next upper level. The highest level of the hierarchy consists of variables that are influenced by variables in the lower levels but do not influence any other variables.

Step 6: A framework is developed, representing a hierarchy of the relationships between LSS CSFs.

Step 7: The ISM framework is described by replacing the relationships depicted in the framework with formal statements.

Step 9: The ISM framework is checked for conceptual inconsistencies. If the group decides that there are some inconsistencies, then it necessary to go back to Step 2. If there are no inconsistencies, then the ISM framework is accepted.

Warfield (1973) recommended that at least eight experts are needed to participate in an ISM technique, groupings have both industrial and academic experts in the domain under study. In this study, nine LSS experts participated in the ISM session. The experts represented various sectors (Healthcare, education, banking, aviation and consulting). During the session, the nine expert opinions were pooled in order to rank the 15 CSFs into the top 5 and discussions were held to decide how the CSFs relate to each other, using various management techniques, such as brainstorming and consensus. The author acted as a facilitator to ensure the efficiency and effectiveness of the process. The objective was to maintain the process focused on the topic keeping the discussion of each topic on track and making sure that all group participants had the opportunity to participate.

The ISM approach has some limitations (Dubey et al. 2016). First, opinions and inputs of selected experts group may include some element of bias. Second, the ISM framework proposed in the study has not been statistically tested and empirically validated. Third, there is a chance and possibility that a few factors might be ignored or overlooked (Jayant et al. 2014; Attri et al. 2013). Chapter 7 presents the findings of the ISM session.

4.13 Research hypotheses

The research question presented in section 4.2.1 guided the development of the research hypotheses (HP, H_1, H_2, and H_3) underpinned by the Donobedian model, which assumes positive correlations between Structure, Process, and Outcome (Donabedian 2002), are as follows:

Table 4.8: Hypotheses

RQ	*To what extent are the STO CSFs positively correlated with LSS successful implementation in UAE hospitals measured by hospital performance?*
Model A *Figure 4.7*	*$HP_{o:}$ STO LSS CSFs are not positively correlated with Hospital Performance in UAE* *HP_{a} :STO LSS CSFs are positively correlated with Hospital Performance in UAE*
Model B *Figure 4.8*	*$H1_{o:}$ Strategic LSS CSFs theme is not positively correlated with Hospital Performance in UAE* *$H1_{a}$:Strategic LSS CSFs theme is positively correlated with Hospital Performance in UAE*

	$H2_{2o}$: Tactical LSS CSFs theme is not positively correlated with Hospital Performance in UAE *$H2_{a}$:Tactical LSS CSFs theme is positively correlated with Hospital Performance in UAE*
	$H3_{o}$: Operational LSS CSFs theme is not positively correlated with Hospital Performance in UAE *$H3_{a}$: Operational LSS CSFs theme is positively correlated with Hospital Performance in UAE*
Model C *Figure 4.9*	*$H4_{o}$: Strategic LSS CSFs theme is not positively correlated with Tactical LSS CSFs theme* *$H4_{a}$: Strategic LSS CSFs theme is positively correlated with Tactical LSS CSFs theme*
	$H5_{o}$: Tactical LSS CSFs theme is not positively correlated with Operational LSS CSFs theme *$H5_{a}$:Tactical LSS CSFs theme is positively correlated with Operational LSS CSFs theme*
	$H6_{o}$: Operational LSS CSFs theme is not positively correlated with Hospital Performance in UAE *$H6_{a}$: Operational LSS CSFs theme is positively correlated with Hospital Performance in UAE*

Moreover, the path diagrams in Figure 4.7 and 4.8 are presented to illustrate Hp, H1, H2, and H3 in Models A and B. The oval symbols represent the latent variables. The arrows represent the hypothesized correlations. To explore another model, the author evaluated Model C (Sequential), as shown in Figure 4.9.

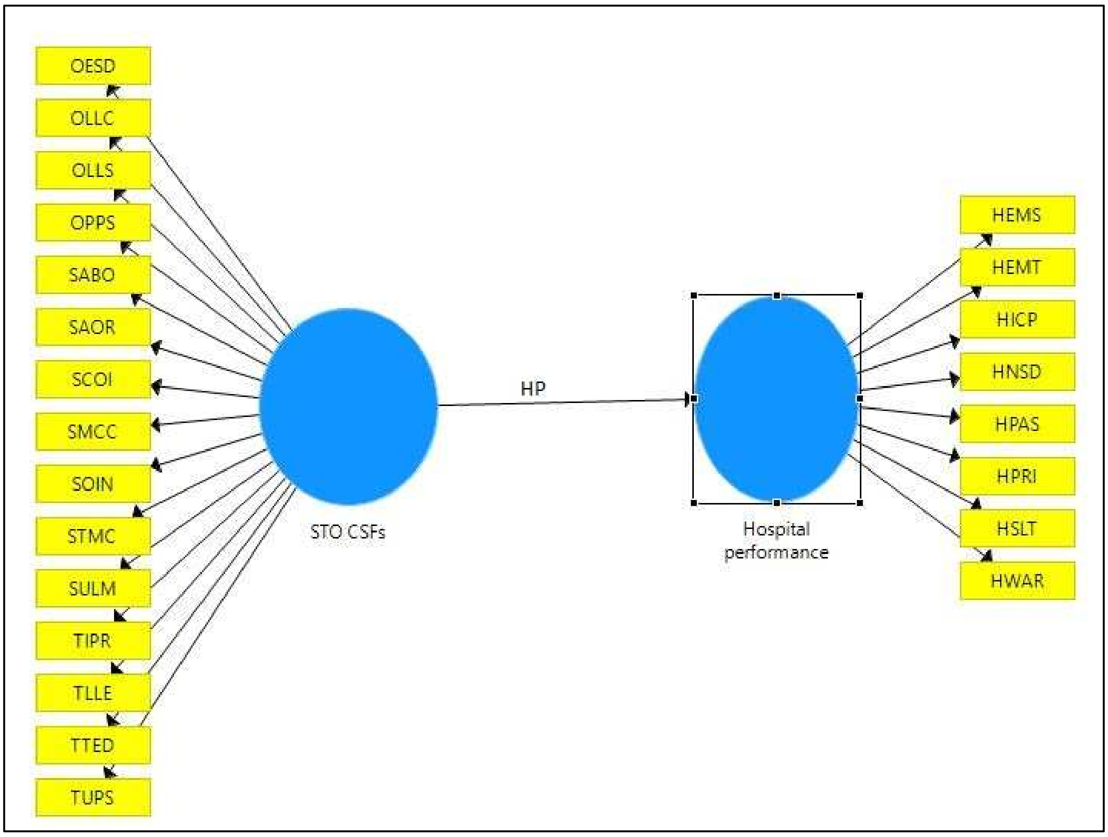


Figure 4.7: Path diagram to illustrate HP hypothesis – Model A
Source: Author. Using SmartPLS Software

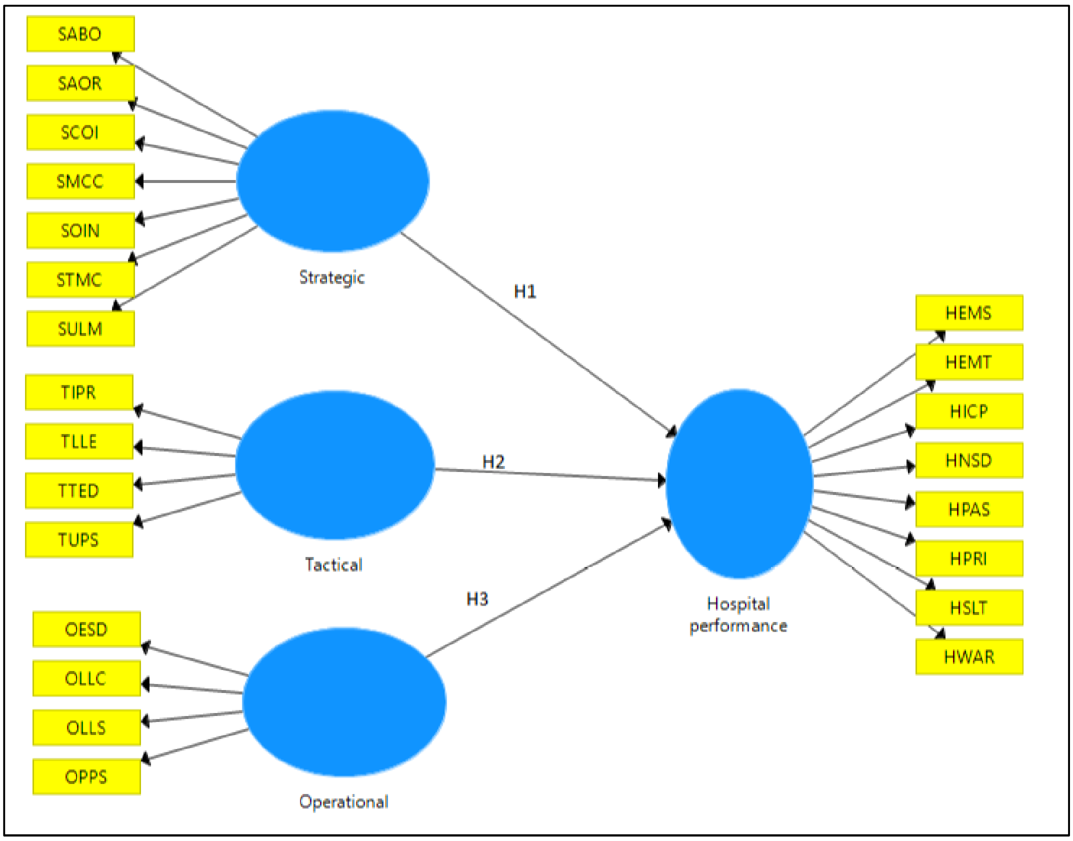


Figure 4.8: Path diagram to illustrate H1, H2, and H3 hypotheses - Model B
Source: Author. Using SmartPLS Software

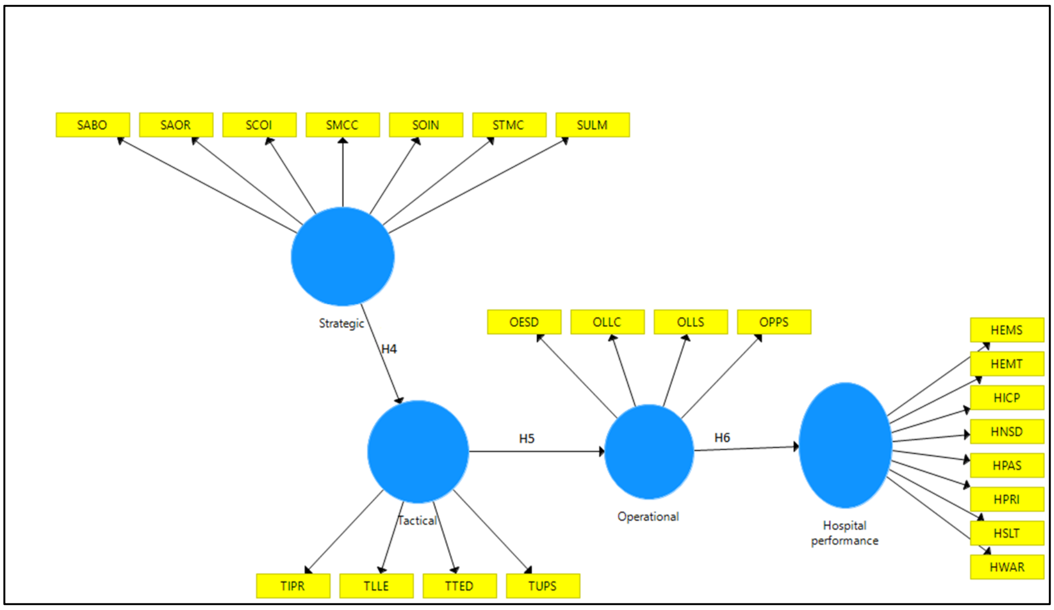


Figure 4.9: Path diagram to illustrate H4, H5, and H6 hypotheses - Model C
Source: Author. Using SmartPLS Software

The choice of the PLS-SEM method to estimate the validity and reliability of the latent variables operationalized using multiple items are discussed in the next section.

4.14 Partial Least Squares Structural Equation Modelling

Three modelling techniques could be applied to test the stated hypotheses: (a) correlation and Multiple Linear Regression (MLR) analysis; (b) Covariance-Based Structural Equation Modelling (CB-SEM); or (c) Partial Least Squares Structural Equation Modelling (PLS-SEM), or 'composite-based SEM' or 'projection to latent structures' structures' (Garson 2016). PLS-SEM path models are used to display the hypotheses and variable relationships to be studied (Hair et al. 2017).

First-generation techniques, such as regression and correlation, may offer limited modelling capabilities in terms of causal relationships. Some scholars consider them ill-suited for modelling latent variables, mediation and multiple moderation effects (Lowry and Gaskin 2014). On the other hand, second-generation techniques such as PLS-SEM can offer better insight into casual inquiry and exploratory research. Initially developed by Herman Wold in the 1960s for econometrics and chemometrics, PLS-SEM has been used in education and marketing research when it comes to exploring success factors (Garson 2016).

A correlational research design was implemented, based on the multivariate statistical analysis of the variables defined in the previous sections. The author chose to use PLS-SEM for the following reasons (Hair et al. 2017; Garson 2016):

(a) PLS-SEM is a non-parametric technique with minimal assumptions about the measurement and distributional characteristics of the variables (Hair et al. 2017). It operates with variables measured using ordinal level scores (e.g. Likert scales used in questionnaires), which may deviate from normality (Wong 2013). MLR and CB-SEM are parametric techniques that assume normally distributed variables measured at the interval level.

(b) MLR and CB-SEM require much larger sample sizes than PLS-SEM, generally over 200 cases, to achieve adequate statistical power. In a review of the use of CB-SEM, Westland (2010) found that the sample sizes used in over 80% of published articles were too small. Consequently, CB-SEM was not appropriate for this study, in which the sample size is 97.

(c) MLR and CB-SEM operate by extracting linear relationships between the variables from the correlation/covariance matrix, but PLS-SEM does not do so. PLS-SEM is a variance-based technique, meaning that it operates by determining how much of the explained variance in the data can be optimized. Consequently, CB-SEM requires goodness of fit tests to determine how well the data fit the linear model, whereas PLS-SEM does not do so (Hair et al. 2017).

(e) PLS-SEM has been used by several other researchers to construct statistical models based on survey data collected in various industries, with applications in organisational and operations management (Abdi and Senin 2015; Asmri 2014; Peng and Lai 2012; Salaheldin 2009; Noori 2015; Marzagão et al. 2007; Prajogo and Sohal 2006; Akter et al. 2011; Carmona-Márquez et al. 2016; Ali et al. 2016; Shazali et al. 2013; Lamine and Lakhal 2018).

The stated hypotheses are underpinned by the concept of partial correlation, which is a measure of the strength and direction of the correlation between two variables whilst controlling for (i.e., eliminating or partialling out) their joint correlation with one or more other variables (Tina and Waliczek 1996). Bivariate correlation analysis only takes into account the correlation between two variables, but bivariate correlations may be spurious, and provide misleading results, because the root cause of a bivariate correlation may be their joint correlation with one or more other variables (Ward 2013). Consequently, a bivariate correlation analysis was not appropriate for this study. The multivariate statistical analysis is necessary because the hypotheses are concerned with the partial correlations between more than two variables.

In summary, the PLS-SEM method was chosen as a regression method capable of analyzing the proposed models in this study. PLS-SEM is used to predict the dependents (i.e. hospital performance) from a set of one or more independents (i.e. LSS CSFs); Hence PLS-SEM is implemented as a path model, handling causal paths relating predictors as well as paths relating the predictors to the response variables (Garson 2016). Moreover, PLS-SEM is considered as a causal modelling approach aimed at maximising the explained variance of the dependent latent constructs' (Hair et al. 2011, p.139) which fits with this study's aim to study the correlation between LSS CSFs and hospital performance. Add to that; the following advantages encouraged the author to use PLS-SEM: the ability to model multiple dependents as well as multiple independents and the ability to handle multicollinearity among the independents. Since the study intent was to test and validate the 3 exploratory models, PLS-SEM was most suited to this study.

4.14.1 Validation and evaluation of the model

The models to address the research questions and to test their associated hypotheses were validated and evaluated using PLS-SEM with SmartPLS 3.0 software (Ringle et al. 2015). Path diagrams to test the hypotheses were drawn using the graphic user interface of SmartPLS, as depicted in Figure 4.7,4.8 and 4.9. The indicators of each CSF latent variables were defined in Table 3.2, and the multiple Hospital Performance measures were defined in Table 3.3. The letters S (Strategic), O (Operational), T (Tactical) and H (Hospital performance) were added in front of the CSF codes to make the identification and sorting easier when using SmartPLS.

4.14.2 Validity, reliability and path coefficients

The procedure used to conduct PLS-SEM using SmartPLS is as follows: A CSV (comma-delimited) file containing the data matrix (i.e., the survey item scores in the columns by the participants in rows) is imported into SmartPLS. All the item scores are standardized using Z-scores. The measurement model is validated by composite factor analysis. The discriminant validity, convergent validity and internal consistency reliability are tested for each latent variable. The quality criteria for assessing discriminant validity, convergent validity and internal consistency reliability are: (a) the loading coefficients for all of the items that constitute each factor should be strong (≥ 0.5) but the cross-loadings on the other factors should be weak (< 0.5), (b) the average variance extracted (AVE) by the indicators that comprise each factor should be at least 50%, and (c) the internal consistency reliability (for the indicators that constitute each factor should be $\geq$ 0.7 (Hair et al. 2017). Researchers usually evaluate the discriminant validity by using cross-loading of indicator, Fornell-Larcker criterion or Heterotrait-Monotrait (HTMT) ratio of correlation (AbHamid et al. 2017). In this study, the author selected the cross-loading and the Fornell-Larcker tests for discriminant validity as they are widely accepted in PLS-SEM research.

For the cross-loading, the value of the cross-loading for each variable should be more than 0.5. If a construct is more correlated with another construct than with its own variables, there is a possibility that the two constructs share the same types of measures and are not conceptually distinct. It also can indicate that the two sets of items cannot discriminate or differentiate the two underlying concepts hypothesised (Chin 2010). A rule to thumb for this test is to have a value of less than 0.71 to ensure there are no high correlations between constructs. If the values are more than 0.71, one may consider joining constructs together, if the theory allows it. Otherwise, one may reconsider the whole model structure. If the loadings for the indicators used to operationalize a latent variable are less than the cross-loadings for the same indicators on another latent variable, then the two latent variables are not conceptually distinct, and there is no discriminant validity.

In the Fornell-Larcker approach, the cross-loadings are compared while the factor loading indicators on the assigned construct have to be higher than all loading of other constructs with the condition that the cut-off value of factor loading is higher than 0.70 (AbHamid et al. 2017). The Fornell-Larcker criterium is based on the assumption that the square root of AVE of the latent constructs should exceed the latent construct's highest correlation with any of the other constructs.

Once the validity and reliability of the measurement model are confirmed, the structural model is evaluated using the standardized path coefficients (β) between the latent variables, as well as the R^2 values. Because the item scores are standardized, the β coefficients can range in value from −1 to +1. The β coefficients indicate the relative strengths and directions (positive or negative) of the partial correlations between the latent variables. In a study by Salaheldin (2009) investigating TQM practices on organizational performance, it was argued that (β) with absolute values of less than 0.10 is to be interpreted as small effects, values around 0.30 as medium effects and lastly values of 0.50 and above imply large effects.

The R^2 values measure the proportion of the variance in each latent variable explained by the variance in the latent variable(s) directed into it. The minimum effect size representing a practically significant effect for social science data is $R^2 = .04$, whereas $R^2 \approx .25$ reflects a 'moderate effect' and $R^2 \approx .64$ indicates a 'strong effect' (Ferguson 2009, p.535).

The final stage of the evaluation of the structural model was to test the statistical significance of each β coefficient after bootstrapping (using N=5000) using the Monte

Carlo method. The mean and standard error (*SE*) of each β coefficient is computed. Two-tailed *t*-tests are conducted to determine if the mean value of each β coefficient is significantly different from zero at the conventional $\alpha = 0.05$ level of significance.

PLS-SEM does not require the initial model to be well specified. Therefore, it is justified to improve the validity and reliability of the model (e.g. by excluding or manipulating specific items within each latent variable in order to ensure that all of the quality criteria are satisfied (Hair et al. 2017).

4.14.3 The moderating effect of control variables

The study explored the effect of specific moderators or control variables, shown in Figure 4.10, that may impact LSS implementation success. A moderator is a factor that affects the strength of the relationship between two other factors (Lowry and Gaskin 2014). Because moderation is an exploratory form of analysis, and not a confirmatory form of analysis, no hypotheses were presented or tested. The moderators in this study were tested to determine if they had any moderating effects using the exploratory 'create moderating effects' procedure in SmartPLS (Wong 2016). The proposed moderators were hospital JCI accreditation status, hospital size (measured by the number of beds), hospital type (Governmental or private) and ISO 9001 certification status.

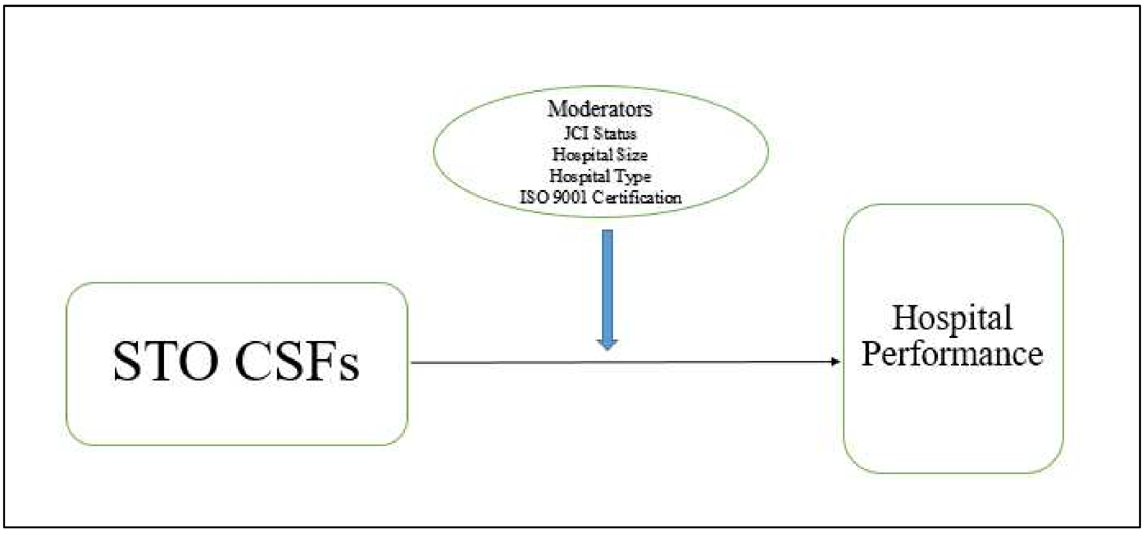


Figure 4.10: The conceptual model with moderators
Source: Author

The effects of specific moderators are explored using PLS-SEM approach in section 6.10.

4.15 Ethical considerations

The author has complied with the rules and regulations of Heriot-Watt University. Ethics in research relates to the researcher's behaviour when research interacts with subjects and affects their rights (Saunders et al. 2009). Hence, the author has ensured that integrity and confidentiality are maintained throughout all processes of the study. Additionally, the author communicated the purpose of the study and possible benefits to the organisations and individuals involved to facilitate access (Saunders et al. 2009). The author provided the choice at the beginning of the survey for the respondent not to continue the survey if they decide so. All material, notes, and results were stored in protected folders and locked cabinets or folders at the author's office or laptop and were not used for other purposes except for this study. All identity information was secured. Participants in the study at the survey or interview phases were provided with a statement or declaration assuring confidentiality with their consent check to be recorded. No exposure to sensitive data was reported, and no conflict of interest was raised during the study.

4.16 Summary

This chapter illustrated the research strategy, design and the phases it will follow to achieve its objectives. It discussed the choice of the philosophical paradigm, research methodology, and methods selected for data collection and analysis. It also provided justification for the choice of the MMR approach (Pragmatic approach) utilising quantitative and qualitative methods for data collection and for data analysis arriving at the use of PLS-SEM to test the hypotheses and the use of ISM to develop the framework. Various techniques such as PLS-SEM, CB-SEM and ISM are becoming popular in recent papers. A number of researchers have explored TQM, Lean, Six Sigma and LSS using these techniques. The Table in Appendix K summarises some of these studies.

This chapter also explained the process of developing the survey questionnaire and the interviewing process. Furthermore, it presented how the questionnaire was validated for content and structure. Table 4.9 presents a summary of the study data collection, methods and data analysis. The next chapter discusses the pilot and main survey results.

Table 4.9: Summary of sampling, data collection and analysis methods

Element	**Survey**	**Interviews**	**Group output**
Type	Descriptive survey	Semi-structured interviews	Brainstorming
Sample selection	-Healthcare LSS professionals lists -UAE industry lists -Meirc Training and Consulting client Lists -Linkedin Lists	-Healthcare LSS professionals lists -UAE industry lists -Linkedin Lists	Quality and LSS experts
Sample selection methods	Purposive sampling	Purposive Sampling	Purposive Sampling
Questionnaire content validation	The survey questionnaire was sent to research experts from academia and quality/ LSS experts to provide feedback on questions' clarity and relevance to the main research questions	Same Survey questions were used for the interviews.	Previous studies structure
Pilot testing	14 respondents from hospitals (LSS practitioners)	NA	NA
Sample size	191 (Total usable) 97 (PLS-SEM)	8 interviews	9 Experts
Unit of analysis	UAE hospitals	UAE hospitals	UAE hospitals and other sectors
Respondents	Quality and LSS professionals in hospitals	Quality and LSS professionals in hospitals	Quality and LSS professionals from various industries
Analysis techniques and software	-SPSS and excel -SmartPLS software	Thematic analysis	ISM structure

Data reporting	-Descriptive analysis -PLS-SEM analysis	Coding and themes report	ISM Framework
Ethical issues	Results used for research purpose only No attempt made to identify individuals All responses remain confidential and anonymous Participants were informed that they stop filling out the questionnaire at any time and for any reason	Results remain anonymous The study explained in detail including risk and expected benefits to participants	Research objectives explained in detail including risk and expected benefits to participants

CHAPTER 5: DESCRIPTIVE ANALYSIS OF PILOT AND MAIN SURVEY RESULTS

5.1 The pilot study

A pilot study is considered a test run of the methodology and research instrument (Baker 1994). The purpose of the pilot study is that it allows researchers to conduct a preliminary analysis or a small-scale version of their study before committing to the main study (Teijlingen and Hundley 2002), assess the selected method and questionnaire design and to modify the design if needed before committing to the main study. Although a pilot study does not guarantee success in the main study, it dramatically increases the likelihood

Pilot studies can suffer from a number of issues, including the possibility of making wrong assumptions or conclusion. Other issues that may arise during a survey could be the misunderstood questions due to phrasing, biased or leading questions. Further, the pilot study is used to develop ideas and not viewed as a study by itself by examining the methods and not to collect data by itself (Glesne 2011). However, some researchers have used pilot studies to provide initial exploratory results into research ideas (Douglas et al. 2015; Antony et al. 2008; Antony 2004). It can be argued that one of the main limitations of pilot studies is the limited sample size that will undermine the statistical conclusion (Teijlingen and Hundley 2002).

The sample size of a pilot study is suggested to be between 10-20% (Baker 1994). The author decided to conduct a pilot study by sending the research questionnaire to 15 selected quality and LSS experts working in UAE hospitals asking them to fill the questionnaire and provide feedback on the questionnaire validity, questions, time to fill and appropriateness.

5.1.1 Subject details

The pilot study respondents were quality and LSS professionals working in UAE hospitals. The author compiled an initial list that contained 125 names. Emails were sent to 21 selected names (Who have been trained by the author on LSS and had projects in their hospitals as they were easily accessible) from 4 leading hospitals in the UAE (Two governmental and two private). The author used Minitab to estimate the minimum sample size, as shown in Figure 5.1. Based on a confidence interval of 95%, the required sample size was 7.

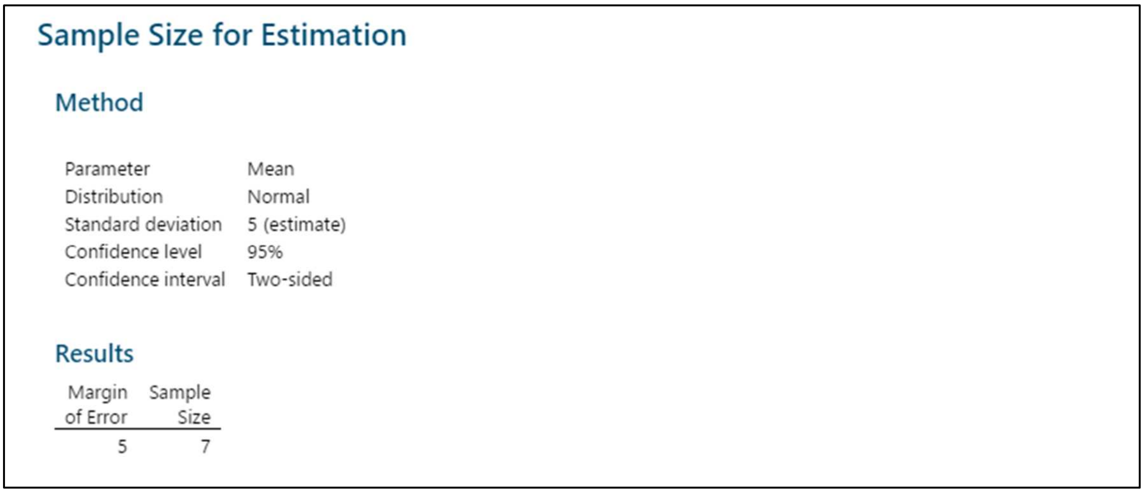


Figure 5.1: Sample size for the pilot study
Source: Author

5.1.2 Pilot questionnaire

Respondents were sent the link to the questionnaire by email inviting them to participate in the pilot study. The email indicated the purpose of the study and confirmed the confidentiality of the data. The email indicated that the respondent had been selected for their experience in quality and LSS. The objective was to check the validity of the questionnaire, the completion time, a list of questions and research method. The author also contacted the selected respondents by phone and urged them to participate in the pilot survey asking for feedback on the questionnaire layout, questions clarity and suitability to the healthcare sector.

5.2 Pilot results and analysis

The results of the pilot study were generally positive. Table 5.1 shows the breakdown of the pilot study questionnaires sent and received. The response rate excluding the 5 wrong emails is 87.5%. This high response rate was as a result of the author’s telephone calls follow-up urging respondents to fill out the questionnaires.

Table 5.1: Pilot questionnaire sample

Number of Questionnaire sent out by email	21
Wrong emails that bounced back	5
Questionnaires received	14
Usable Questionnaires	10
Response rate	87.5%

In summary, the following observations were made as a result of the pilot study:

- The responses arrived within 7 days.
- SurveyMonkey data indicated that the average time taken to fill out the questionnaire was 12 minutes which was appropriate and should not cause response fatigue during the main survey (Galesic and Bosnjak 2009) .
- Verbal feedback from 2 respondents indicated that the questions were clear, understood, and suitable to the healthcare industry.
- Not all questions were answered.

The fourteen questionnaires received contained information about the demographics of the respondents (Section 1 of the questionnaire) while information about CSFs, LSS impact on hospital performance, tools usage and CSF ranking was also collected in sections 2 to 5. The next sections present the analysis of the data received.

5.2.1 Demographic information

The descriptive analysis is shown below:

Hospital location: The respondents were from the two main regions in the UAE, namely Abu Dhabi and surrounding regions and Dubai, the main and well-funded emirates in UAE. Two respondents did not answer this question

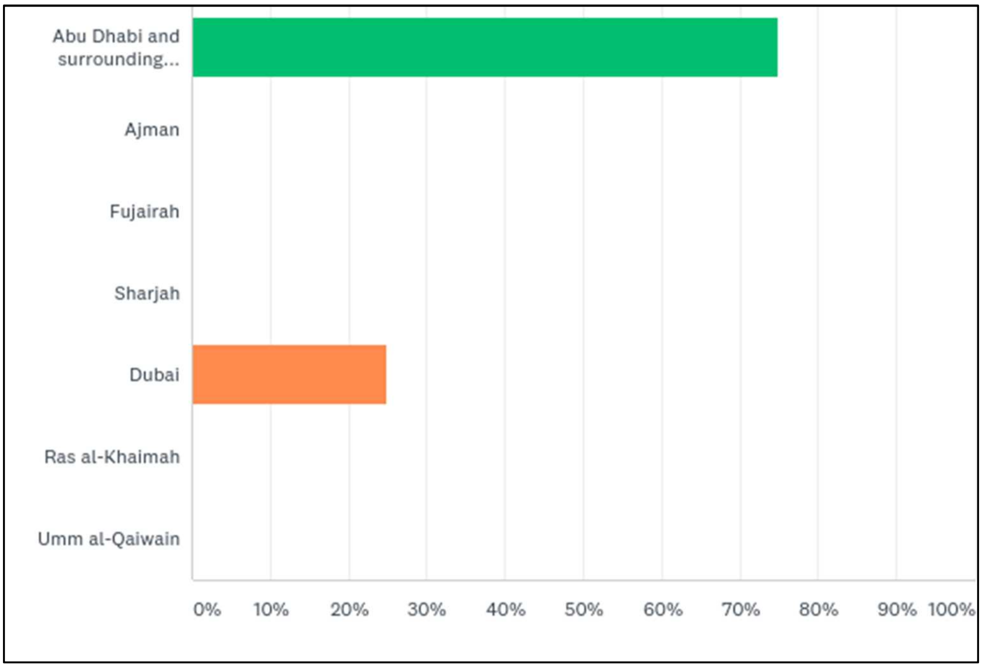


Figure 5.2: Hospital location
Source: Author

Number of hospital employees: The breakdown percentages are shown in the graph below. More than 75% of the hospitals included in the pilot study came from large hospitals.

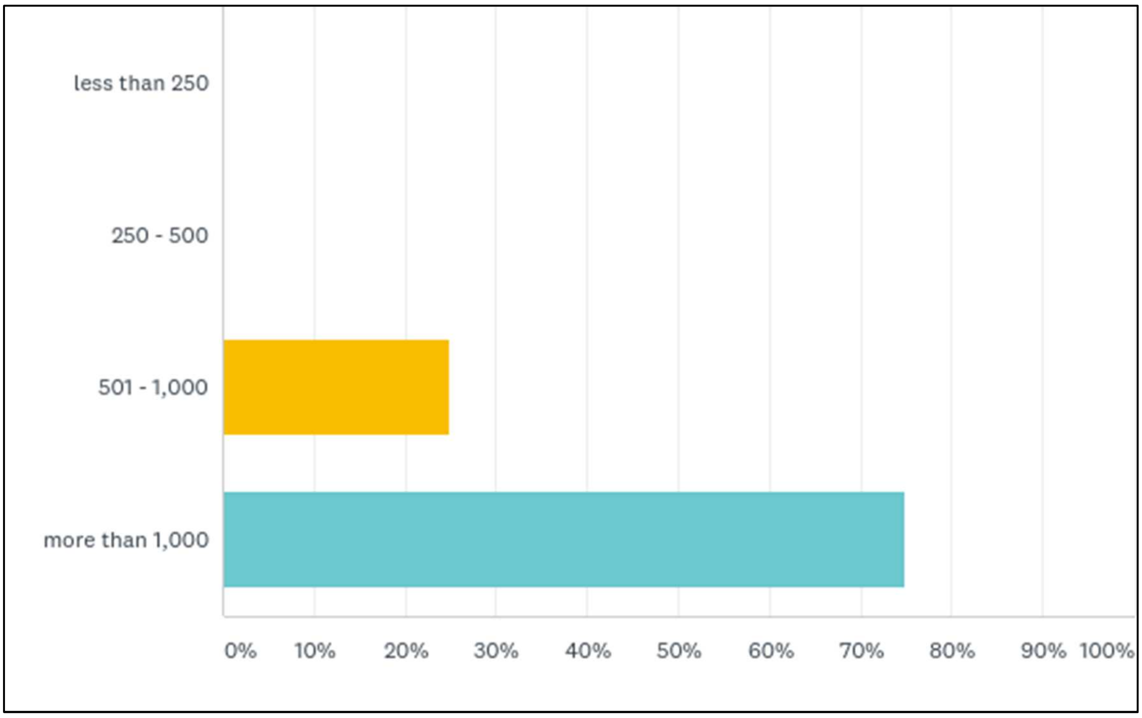


Figure 5.3: Number of hospital employees
Source: Author

Type of hospital: Government hospitals were 75% of the pilot study, while 25% of the pilot respondents were from private hospitals.

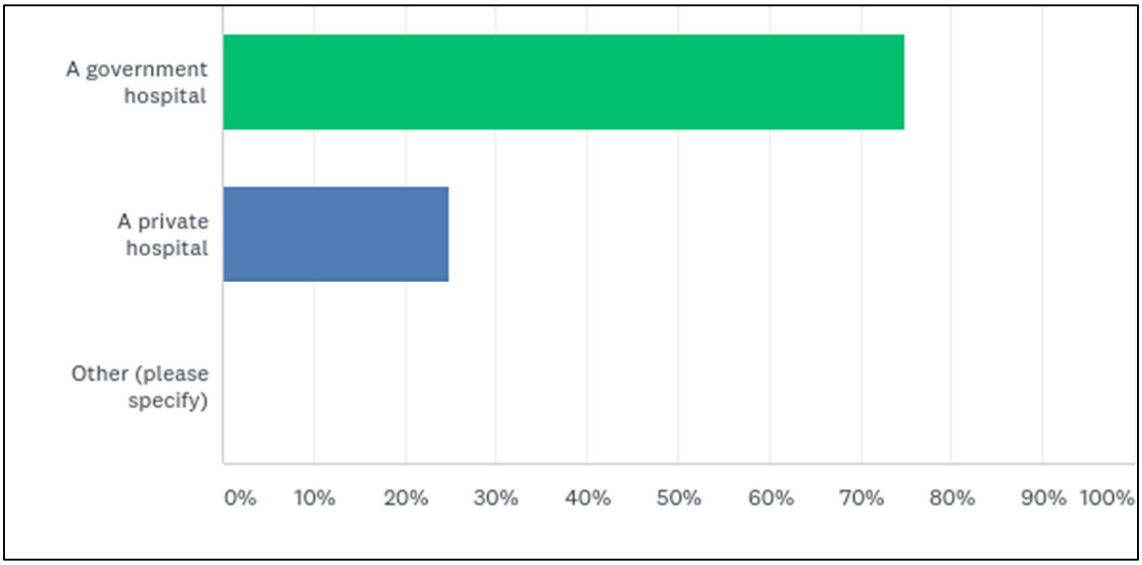


Figure 5.4: Type of hospital
Source: Author

<u>Number of patient beds:</u> Most of the respondents in the pilot study (75%) had 201-500 patients beds.

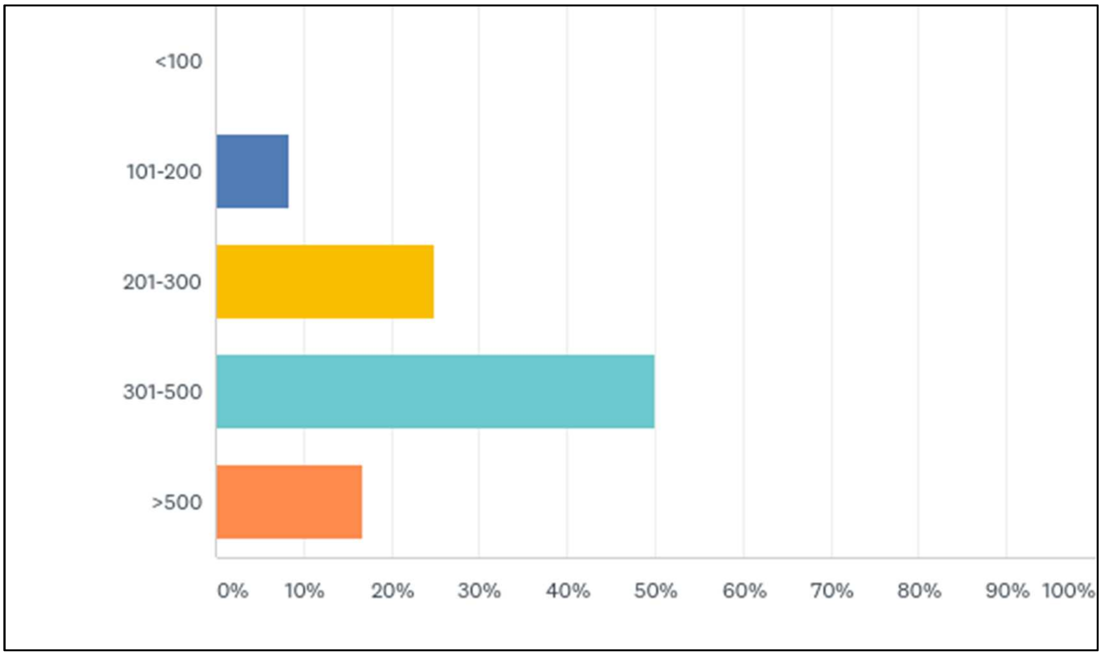


Figure 5.5: Number of patient beds
Source: Author

<u>Position of respondents:</u> More than 70% of the respondents were mainly administrative managers and directors (e.g. Quality and LSS Managers) while 15% were physicians.

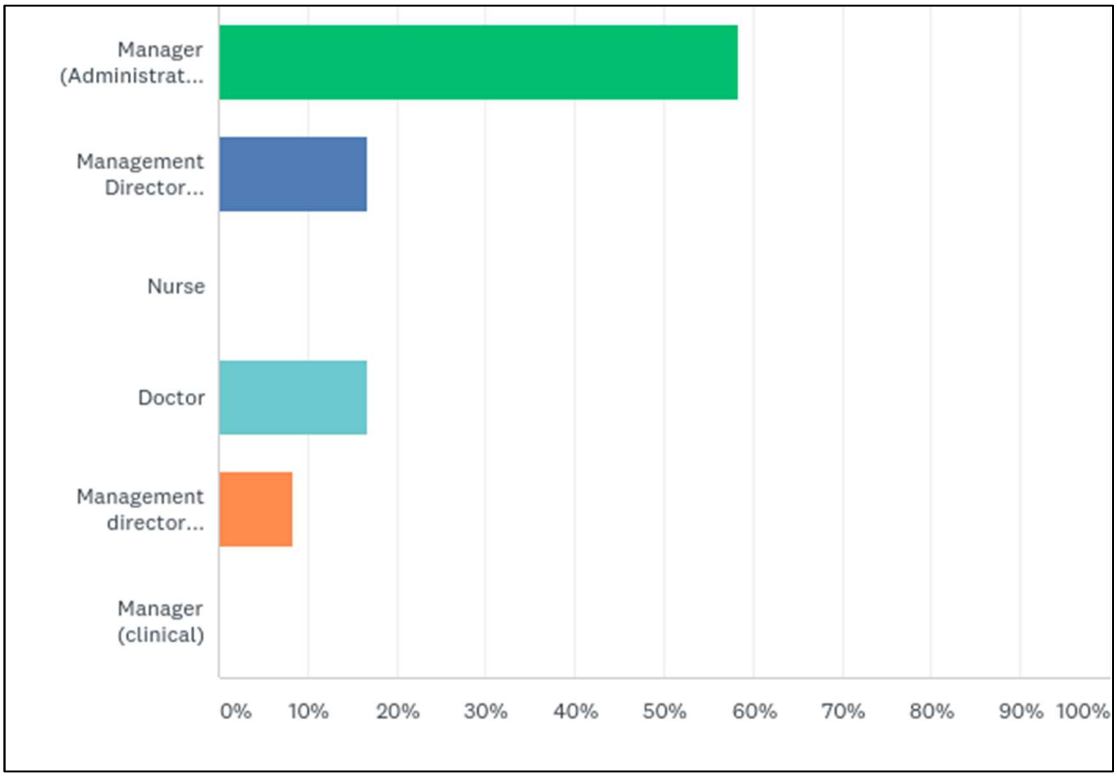


Figure 5.6: Job positions of respondents
Source: Author

Current accreditation status of the hospital: All of the hospitals participating in the pilot survey were accredited by Joint Commission International (JCI) while 75% of them had won a local quality award. Less than 20% were ISO 9001 certified.

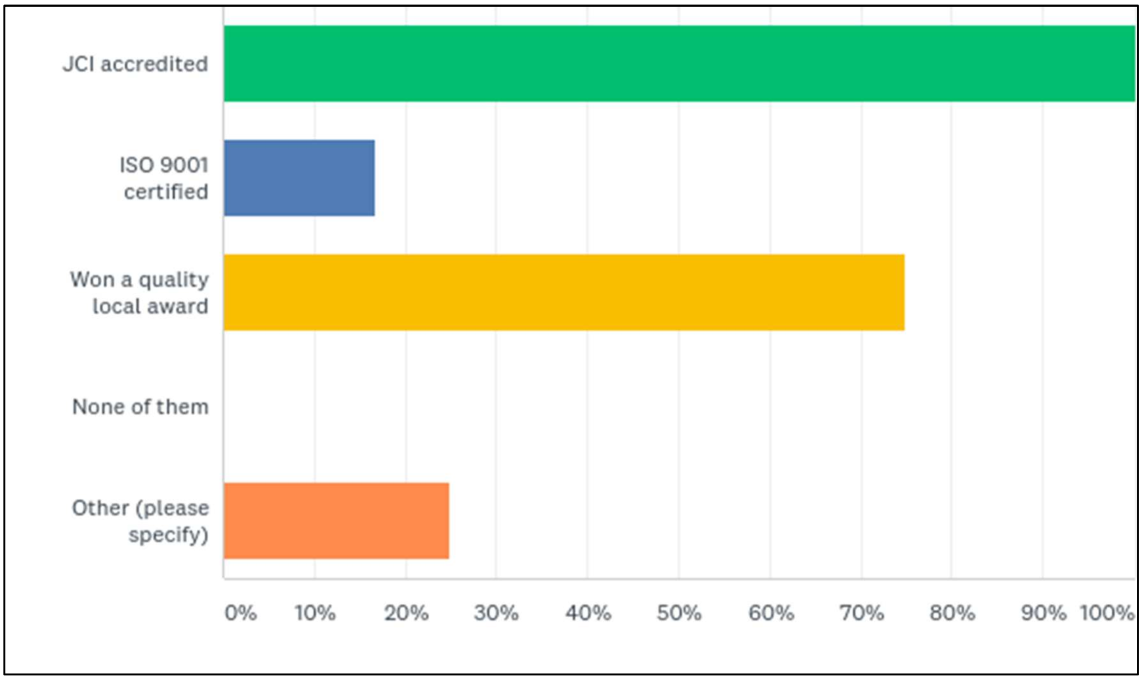


Figure 5.7: Current accreditation status of hospitals
Source: Author

LSS Level of implementation: All of the respondents reported that their hospitals are currently implementing or implemented LSS before.

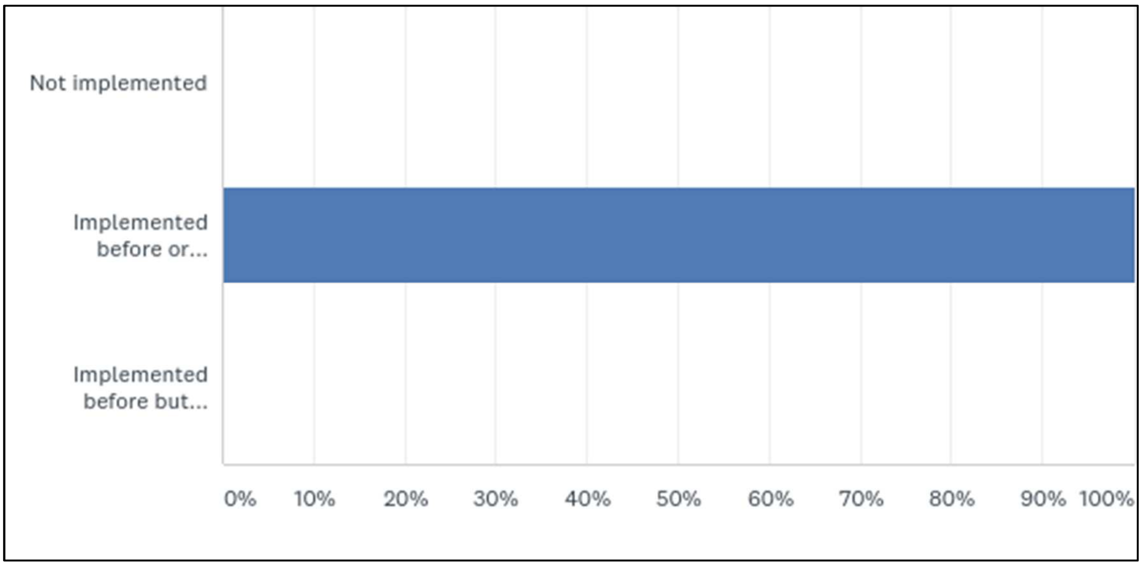


Figure 5.8: LSS Level of implementation
Source: Author

Length of LSS deployment: More than 50% of the hospitals in the pilot sample have been implementing LSS for more than 4 years, which will hopefully provide in-depth information once the main study in conducted.

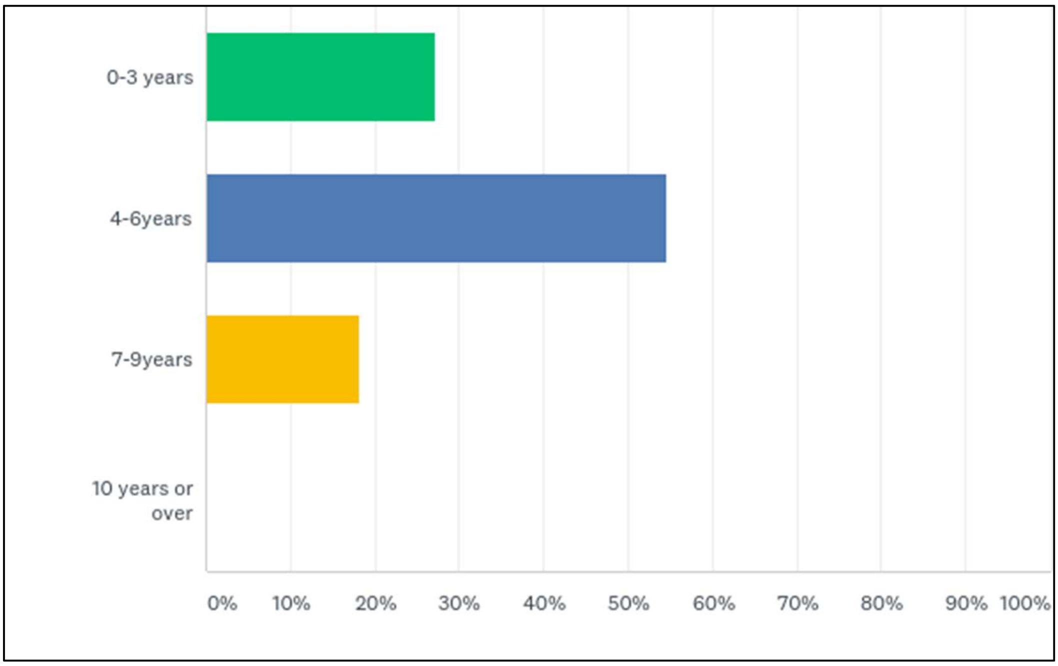


Figure 5.9: Length of LSS deployment
Source: Author

<u>Areas of LSS implementation at the hospital:</u> The top three areas where LSS is implemented at were Human Resources, clinical and hospital operations such as admission processes. Other areas included customer service, finance and procurement. Figure 5.10 shows the breakdown of the answers.

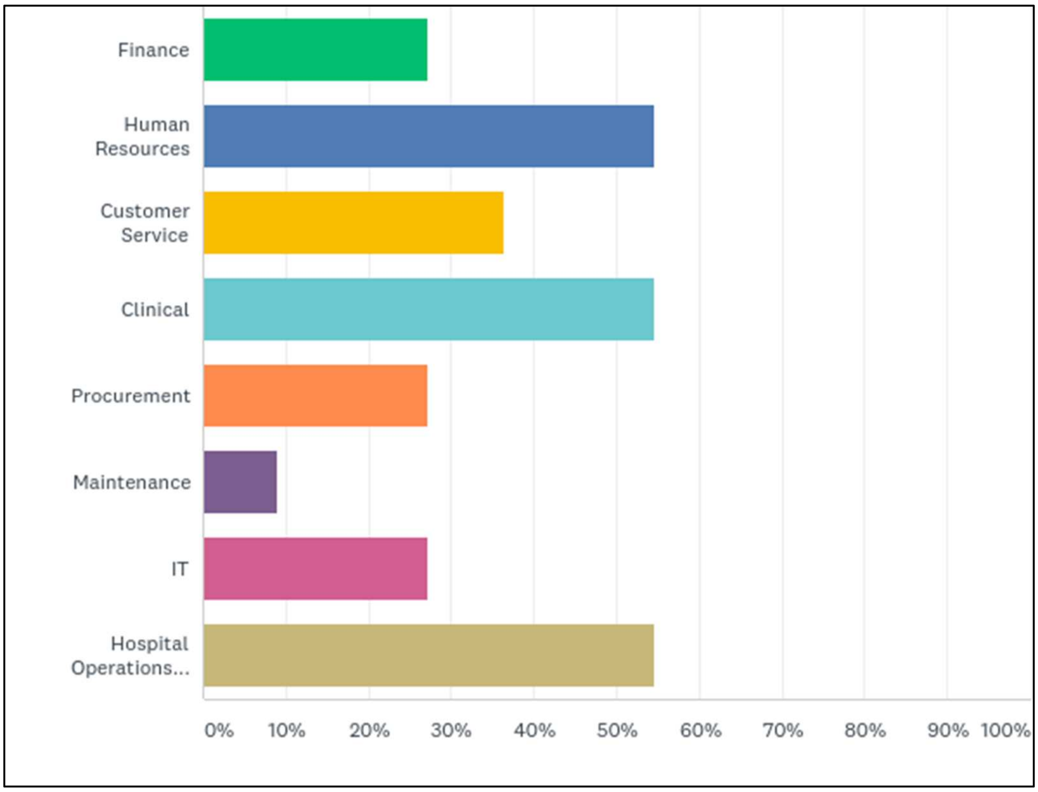


Figure 5.10: Areas of LSS implementation
Source: Author

5.2.2 CSFs information

The pilot study collected information about the importance of 15 CSFs in supporting LSS implementation. The following is a descriptive analysis of the results with regards to each CSF question.

When it comes to Lean Six Sigma top Management Commitment to LSS: All of the respondents (100%) agreed with this statement. Table 5.2 shows the breakdown of the answers.

Table 5.2: Top management CSF analysis

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Top Management are fully committed to performance improvements	0.00% 0	0.00% 0	0.00% 0	10.00% 1	30.00% 3	60.00% 6	10	5.50

When it comes to introducing and managing culture change with respect to Lean Six Sigma: Majority of the respondents agreed with the statement 90% while 10% disagreed with the statement. Table 5.3 shows the breakdown of the answers.

Table 5.3: Managing culture change CSF analysis

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
In general, the corporate culture in our organization supports using Lean Six Sigma.	0.00% 0	0.00% 0	10.00% 1	30.00% 3	50.00% 5	10.00% 1	10	4.60

When it comes to introducing and managing Lean Six Sigma resources: Only 60% of the respondents agreed with the statement while 40% disagreed with the statement. Table 5.4 shows the breakdown of the answers.

Table 5.4: LSS resources analysis

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Our hospital has a dedicated budget for Lean Six Sigma implementation	30.00% 3	0.00% 0	10.00% 1	40.00% 4	10.00% 1	10.00% 1	10	3.30

When it comes to linking Lean Six Sigma to customers: Majority of the respondents agreed with the statement 90% while 10% disagreed with the statement. Table 5.5 shows the breakdown of the answers.

Table 5.5: Linking LSS to customer analysis

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
We select and implement projects with high impact on customer and patient satisfaction	0.00% 0	10.00% 1	0.00% 0	10.00% 1	0.00% 0	80.00% 8	10	5.40

When it comes to introducing and managing Lean Six Sigma organisational infrastructure: This question introduced an attention trap by reversing the scale. Results were mixed as 50% agreed while 50% disagreed. Table 5.6 shows the breakdown of the answers.

Table 5.6: LSS infrastructure analysis

	STRONGLY AGREE	MODERATELY AGREE	MILDLY AGREE	MILDLY DISAGREE	MODERATELY DISAGREE	STRONGLY DISAGREE	TOTAL	WEIGHTED AVERAGE
We adopt the creation of cross-functional teams within the hospital	10.00% 1	20.00% 2	10.00% 1	10.00% 1	30.00% 3	20.00% 2	10	3.90

When it comes to aligning Lean Six Sigma projects to business objectives: Majority of the respondents agreed with the statement 90% while 10% disagreed with the statement. Table 5.7 shows the breakdown of the answers.

Table 5.7: LSS alignment with business objectives analysis

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
We target Lean Six Sigma projects that have a direct impact on strategic, financial or operational goals of the hospital	0.00% 0	10.00% 1	0.00% 0	20.00% 2	20.00% 2	50.00% 5	10	5.00

When it comes to aligning Lean Six Sigma projects with our suppliers: Only 40% of the respondents agreed with the statement while 60% disagreed with the statement. Table 5.8 shows the breakdown of the answers.

Table 5.8: LSS alignment with suppliers

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
We involve suppliers in our Lean Six Sigma projects	20.00% 2	10.00% 1	30.00% 3	30.00% 3	0.00% 0	10.00% 1	10	3.10

When it comes to training and education related to Lean Six Sigma: All of the respondents (100%) agreed with this statement. Table 5.9 shows the breakdown of the answers.

Table 5.9: LSS training and education analysis

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
We consider training in Lean Six Sigma principles important	0.00% 0	0.00% 0	0.00% 0	30.00% 3	50.00% 5	20.00% 2	10	4.90

When it comes to usage of problem-solving and statistical tools within Lean Six Sigma: All of the respondents (100%) agreed with this statement. Table 5.10 shows the breakdown of the answers.

Table 5.10: Usage of problem-solving and statistical tools analysis

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
We use various tools and techniques during Lean Six Sigma implementation	0.00% 0	0.00% 0	0.00% 0	20.00% 2	40.00% 4	40.00% 4	10	5.20

When it comes to linking Lean Six Sigma to our employees: Majority of the respondents agreed (80%) while 20% disagreed with this statement. Table 5.11 shows the breakdown of the answers.

Table 5.11: Linking LSS to employees analysis

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Our employees are eager to participate in Lean Six Sigma projects	0.00% 0	0.00% 0	20.00% 2	50.00% 5	20.00% 2	10.00% 1	10	4.20

When it comes to understanding Lean Six Sigma: 70% of the respondents agreed with this statement while 30% disagreed. Table 5.12 shows the breakdown of the answers.

Table 5.12: Understanding LSS analysis

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
We fully understand the Lean Six Sigma methodology (DMAIC)	0.00% 0	20.00% 2	10.00% 1	20.00% 2	20.00% 2	30.00% 3	10	4.30

When it comes to incentives linked to Lean Six Sigma: 60% of the respondents agreed with this statement while 40% disagreed. Table 5.13 shows the breakdown of the answers.

Table 5.13: LSS incentives analysis

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
We use Lean Six Sigma accomplishments as one of the key measures for managing performance and compensation	10.00% 1	0.00% 0	30.00% 3	30.00% 3	10.00% 1	20.00% 2	10	3.90

When it comes to communication linked to Lean Six Sigma : This question introduced an attention trap by reversing the scale. Only 30% agreed while 70% disagreed. No issues were identified with the attention of respondents. Table 5.14 shows the breakdown of the answers.

Table 5.14: LSS communication analysis

	STRONGLY AGREE	MODERATELY AGREE	MILDLY AGREE	MILDLY DISAGREE	MODERATELY DISAGREE	STRONGLY DISAGREE	TOTAL	WEIGHTED AVERAGE
Our organisational communication provides information about Lean Six Sigma projects and progress	0.00% 0	20.00% 2	10.00% 1	40.00% 4	20.00% 2	10.00% 1	10	3.90

When it comes to measuring performance (Scorecards or dashboards) linked to Lean Six Sigma: 60% of the respondents agreed with this statement while 40% disagreed. Table 5.15 shows the breakdown of the answers.

Table 5.15: Performance linked to LSS analysis

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Lean Six Sigma results are used as tools to manage performance that are linked to financial measures	10.00% 1	10.00% 1	10.00% 1	40.00% 4	20.00% 2	10.00% 1	10	3.80

When it comes to my understanding of Lean Six Sigma: This was another attention trap or bogus question. As expected, the majority disagreed (80%) while 2 respondents (20%) agreed. Table 5.16 shows the breakdown of the answers.

Table 5.16: Own understanding of LSS analysis

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Lean Six Sigma has absolutely nothing to do with healthcare management	80.00% 8	0.00% 0	0.00% 0	0.00% 0	10.00% 1	10.00% 1	10	1.90

When it comes to Project prioritisation, selection, management, and tracking linked to Lean Six Sigma: All of the respondents agreed with the statement (100%). Table 5.17 shows the breakdown of the answers.

Table 5.17: LSS project prioritisation,management tracking analysis

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Our project selection focuses on poorly performing areas of the hospital	0.00% 0	0.00% 0	0.00% 0	20.00% 2	40.00% 4	40.00% 4	10	5.20

Challenges/barriers for Lean Six Sigma deployment or implementation: This question allowed multiple selections. The top five barriers reported were lack of resources, internal resistance, unmanaged expectations, changing business focus and competing projects. Figure 5.11 shows the detailed results.

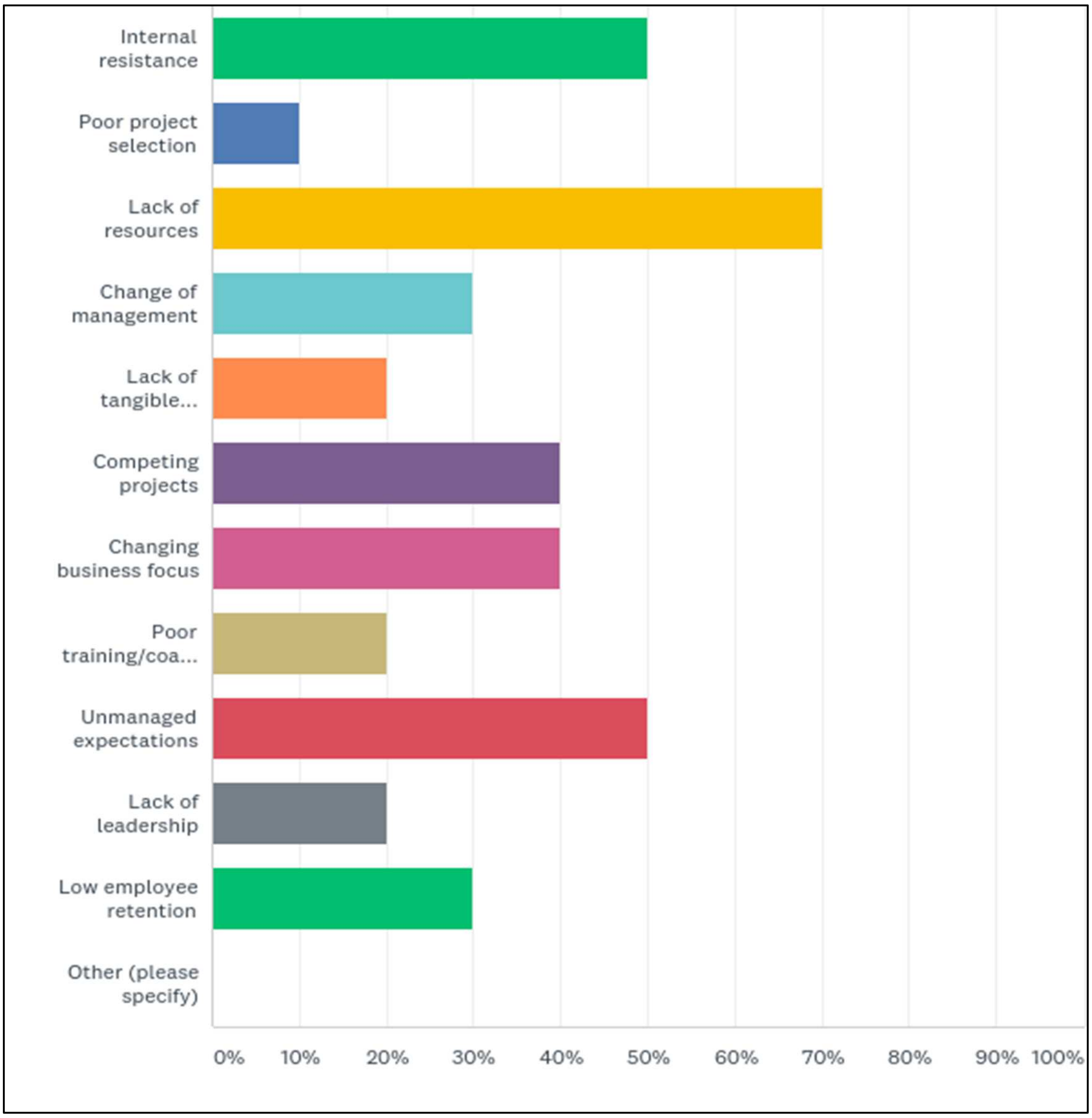


Figure 5.11: Barriers to LSS implementation
Source: Author

5.2.3 Impact of LSS on Hospital Performance

Results show that the highest impact of LSS is on productivity improvement, waste reduction and reduction in errors and defects. There was one attention trap question that all respondents picked up, indicating a high level of attention for this group. One or two participants did not answer this question. Table 5.18 shows the breakdown of the answers.

Table 5.18: Impact of LSS on hospital performance analysis

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Outpatients' satisfaction has increased	0.00% 0	0.00% 0	11.11% 1	66.67% 6	22.22% 2	0.00% 0	9	4.11
Lead-time for hospital services has decreased	0.00% 0	0.00% 0	0.00% 0	66.67% 6	22.22% 2	11.11% 1	9	4.44
Employee satisfaction has increased	0.00% 0	22.22% 2	22.22% 2	33.33% 3	22.22% 2	0.00% 0	9	3.56
The turnover rate of employees has decreased	11.11% 1	11.11% 1	11.11% 1	55.56% 5	11.11% 1	0.00% 0	9	3.44
Productivity has improved	0.00% 0	0.00% 0	0.00% 0	50.00% 4	37.50% 3	12.50% 1	8	4.63
Number of service defects, errors, or breakdowns has decreased	0.00% 0	0.00% 0	11.11% 1	33.33% 3	44.44% 4	11.11% 1	9	4.56
The competitive position of the hospital's has strengthened	0.00% 0	0.00% 0	37.50% 3	37.50% 3	25.00% 2	0.00% 0	8	3.88
If you are actually reading this question, then please reply with "Strongly disagree	100.00% 9	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	9	1.00
The waste in our operations and processes has reduced	0.00% 0	0.00% 0	0.00% 0	44.44% 4	44.44% 4	11.11% 1	9	4.67

5.2.4 Results of LSS implementation

This Question asked respondents about their perception of the results of LSS. Although the definition of classifies as successful was not defined, more than 55% reported it was successful or extremely successful. However, around 44% reported that the implementation was not significant. Table 5.19 shows the breakdown of the answers.

Table 5.19: LSS implementation results analysis

ANSWER CHOICES	RESPONSES	
Extremely successful	11.11%	1
Successful	44.44%	4
Not significant	44.44%	4
Negative	0.00%	0
Extremely negative	0.00%	0
TOTAL		9

5.2.5 Extent of LSS tools usage

The most frequent used LSS tools were 5-Why analysis, brainstorming, cause and effect diagrams, check sheets, process mapping and flowcharts, project charter. The following tools were also used: 5S, balanced scorecard, histogram, Measurement system analysis (MSA), PERT chart, Pareto chart, relations diagrams, Value Stream Mapping (VSM) and control charts. Figure 5.12 shows the breakdown of the answers.

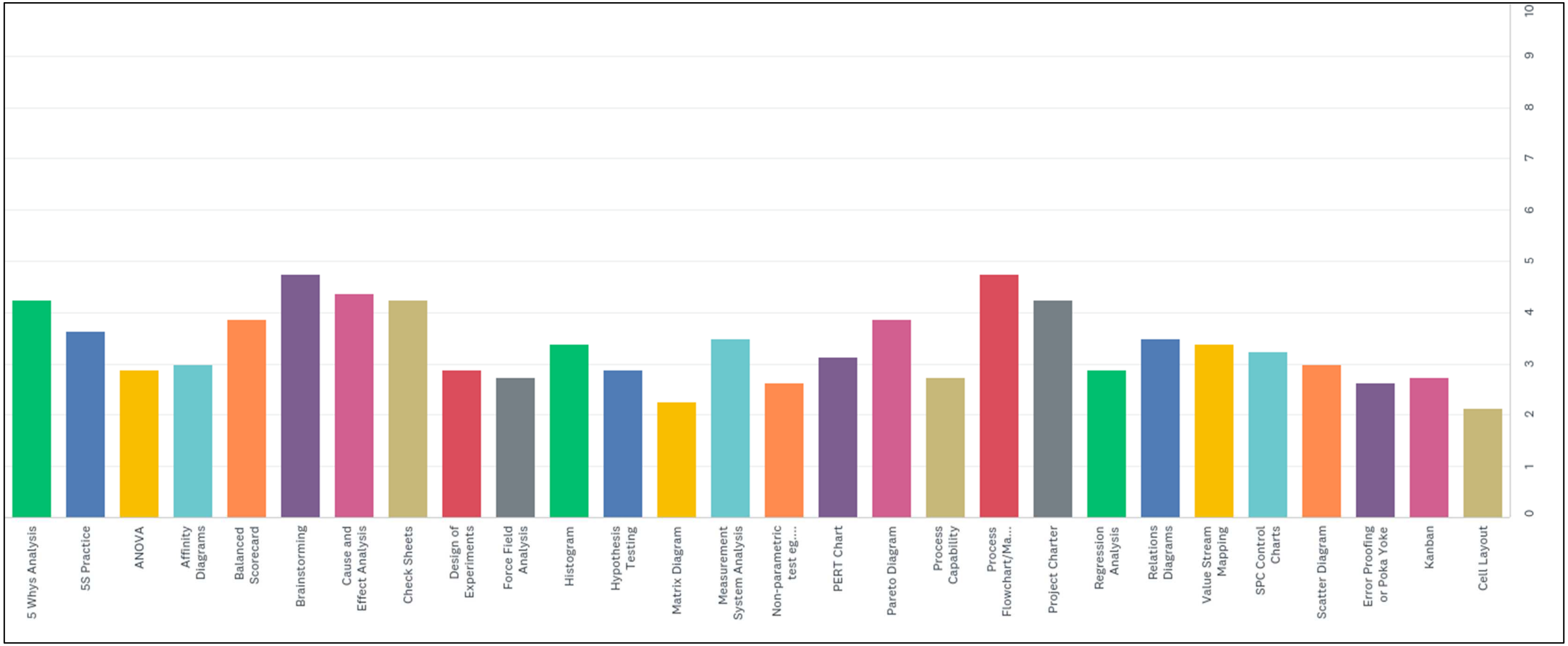


Figure 5.12: The LSS tools usage extent
Source: Author

5.2.6 Ranking of CSFs

The results in this section broadly were as expected and mentioned in the literature. The questions sought the respondent's perception in terms of the importance of the CSFs. The responses revealed the following top 7 CSFs: Top Management involvement and commitment, Availability of resources, understanding of LSS methodology, communication of information, management of cultural change, training and education, applying LSS projects to business objectives. Figure 5.13 and Table 5.20 show detailed results. One social desirability question (Do I Gossip at time?) was used in this set. Three responses indicated that gossip is an important CSF. The author believes that this question was not clear and may have confused the respondents.

Figure 5.13: Radar chart for CSF ranking
Source: Author

Table 5.20: LSS implementation results analysis

	NOT VERY IMPORTANT	NOT IMPORTANT	IMPORTANT	VERY IMPORTANT	CRITICAL	TOTAL	WEIGHTED AVERAGE
Visible top management involvement and Commitment	0.00% 0	0.00% 0	0.00% 0	22.22% 2	77.78% 7	9	4.78
Management of cultural change	0.00% 0	0.00% 0	11.11% 1	77.78% 7	11.11% 1	9	4.00
Availability of resources (financial, time)	0.00% 0	0.00% 0	11.11% 1	33.33% 3	55.56% 5	9	4.44
Organisational infrastructure	0.00% 0	22.22% 2	22.22% 2	44.44% 4	11.11% 1	9	3.44
Linking LSS to customers	11.11% 1	0.00% 0	22.22% 2	55.56% 5	11.11% 1	9	3.56
Aligning LSS projects to business objectives	0.00% 0	0.00% 0	22.22% 2	55.56% 5	22.22% 2	9	4.00
Linking LSS to suppliers	11.11% 1	11.11% 1	66.67% 6	11.11% 1	0.00% 0	9	2.78
Training and education	0.00% 0	0.00% 0	22.22% 2	55.56% 5	22.22% 2	9	4.00
Usage of problem-solving and statistical thinking and tools	0.00% 0	0.00% 0	11.11% 1	77.78% 7	11.11% 1	9	4.00
Linking LSS to employees	0.00% 0	0.00% 0	44.44% 4	33.33% 3	22.22% 2	9	3.78
Understanding LSS methodology	0.00% 0	0.00% 0	22.22% 2	44.44% 4	33.33% 3	9	4.11
Incentive programme	0.00% 0	0.00% 0	44.44% 4	33.33% 3	22.22% 2	9	3.78
Communication of information	0.00% 0	0.00% 0	22.22% 2	44.44% 4	33.33% 3	9	4.11
Established LSS dashboard	0.00% 0	11.11% 1	44.44% 4	44.44% 4	0.00% 0	9	3.33
Gossip at times	22.22% 2	44.44% 4	33.33% 3	0.00% 0	0.00% 0	9	2.11
Project prioritisation selection, management, and tracking skills	0.00% 0	0.00% 0	33.33% 3	44.44% 4	22.22% 2	9	3.89

5.2.7 Future of LSS

Around 80% indicated that LSS is growing in importance, while around 20% indicated that LSS is becoming less important. Figure 5.14 shows the breakdown of the answers.

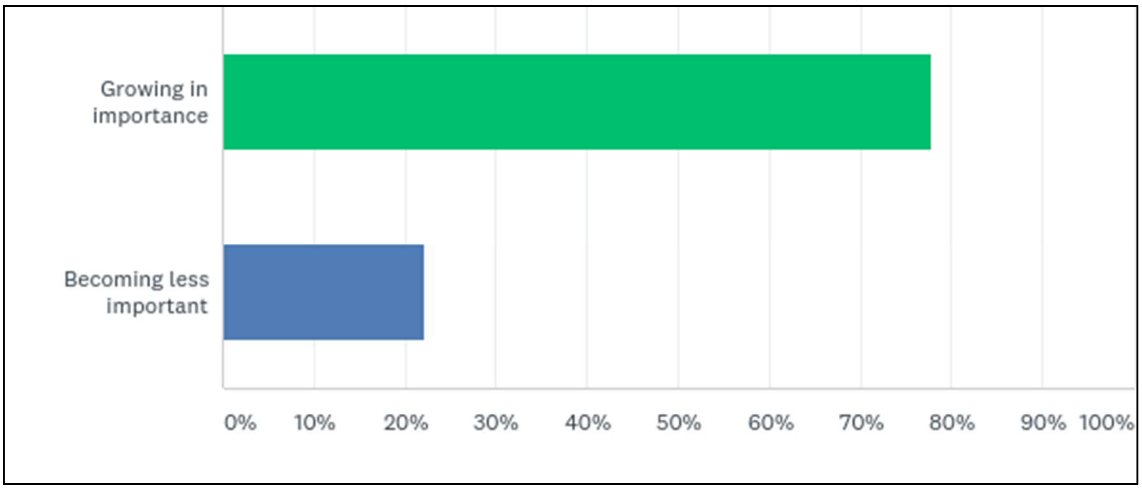


Figure 5.14: Future of LSS
Source: Author

5.3 Summary and the final study questionnaire

The pilot study was not meant to draw conclusions on the extent of LSS implementation but to validate the data collection methods and questions appropriateness and make adjustments to the questionnaire. As a result of the pilot study, the questionnaire was modified to reflect the following:

- Social desirability questions were removed from the main study questionnaire.
- One attention (bogus) question was retained in section 2.
- The reverse scale ranking was kept in the CSF section for 2 questions.
- The question of LSS tools was removed to reduce the length of the questionnaire.
- Since the study targets quality and LSS practitioners in hospitals, the question on staff position becomes redundant; hence, it was removed from the final questionnaire.

Moreover, the pilot survey did not reveal any issues with data collection methods or the 6-point Likert scale and validated the clarity of the questions. Since the pilot study sample came from the same main study population, the 10 valid pilot results were added to the final main study results.

As a result, the final study questionnaire was updated. The final questionnaire and invitation email are included in Appendix H.

5.4 The main survey

The following sections present and discuss the descriptive statistics, such as frequencies, percentages and ranking according to weighted averages to systematically and meaningfully highlight any patterns or trends of the survey results in terms of LSS application. Statistical Package for Social Sciences (SPSS), SurveyMonkey built-in data analysis and Microsoft Excel were used for quantitative data analysis to generate the charts.

5.4.1 Response breakdown

The main research questionnaire was sent, as explained in sections 4.10.1 and 4.12.1. The questionnaire was managed using the SurveyMonkey platform. Two weeks after the first email batch, a thank-you/reminder email was sent. Finally, another reminder was sent after four weeks and another after 2 weeks. The same approach was used on social platforms. After 12 weeks, the survey was closed. The total collected number of responses was 260. Table 5.21 summarizes the collected responses sources.

Table 5.21: Research sample response collectors

Response Collector	**Targeted Sample**	**Total Responses**
Email invitations	665	209
Social media and posts	41	41
Pilot results	10	10
Totals	**716**	**260**
Total Response rate	260/716= **36.31%**	

Source: Author

5.4.2 Response rate

Although researchers have different views on what is an acceptable response rate, a 20-40 per cent is considered acceptable in the field of operations management (Frohlich 2002). A review of different studies conducted in the field of Lean Six Sigma or LSS shows that a lower rate has been acceptable in some studies. This is attributed to the fact that the LSS field is relatively new. For example (and in similar LSS studies), Shah (2008) had an 8.9 per cent response rate in his study while Albliwi et al. (2017) had a response rate of 25.5 per cent. Since this study is targeting UAE hospitals that have implemented LSS as an approach to improve their processes, a lower response rate was inevitable as previous studies indicate that the implementation of LSS has not been predominant in developing countries (Albliwi et al. 2017; Aljabr 2015; Al-Sharif 2011; Al-Aomar 2012). Hence, a response rate of 36.31% can be considered to be decent (Frohlich 2002). It is noted that this response rate covers both hospitals that implemented and did not implement the LSS.

5.5 Questionnaire results preparation and preliminary data processing

It is the norm that collecting data from surveys is followed by conducting an exercise of data cleaning and preparation for the analysis to ensure that the data is complete and free from errors and other unintended omissions (Nachmias and Nachmias 1996). This process emphasizes the need to ensure that the data is valid and reliable for subsequent PLS-SEM analysis (Hair et al. 2017). Therefore, the following sections will discuss the missing data analysis and non-response bias.

5.5.1 Results, missing and discarded data

Table 5.22 summarises the breakdown of the received and missing responses.

Table 5.22: Responses breakdown

Total number of responses received	**260**
Incomplete responses (Respondents abandoned the survey at the initial stage after consent question)	69
Total usable responses	**191**
No. of hospitals that implements or implemented LSS	123
No. of hospitals that have not implemented LSS	65
No. of hospitals that have implemented LSS and abandoned	3
Missing responses (Respondents who did not answer question Q11 onwards while indicating they implemented LSS)	21
Discarded responses (Attention question Q25)	4
Missing values under hospital performance indicators	4
Valid sample size for PLS-SEM (123+3-21-4-4)	**97**

Source: Author

When analysing data, a careful review of missing data should be conducted to ensure that Type I error (the incorrect rejection of true null hypothesis) and Type II error (the failure to reject a false null hypothesis) are minimised (Bryman 2015). In this study, the extent of missing data was analysed. Further, the systematisation of the missing data was also examined to reveal if a considerable number of respondents refrained from answering specific questions, which may result in analysis issues. The analysis showed that none of the questions exhibited a high number of missing values or showed systematisation. The portion of respondents that abandoned the survey at the initial stages (26.4%) did not pose a problem as it is highly likely that the survey reached some respondents that were not part of the target sample. Hence, they must have abandoned the survey after the first question.

Regarding the assessment of the attention questions, while comparing specific answers with the previous ones, four respondents appeared to agree or strongly agree with the attention question and maintained the same response with all other questions before and after. This could demonstrate that these respondents were not attentive. Therefore, their responses were not taken to account for the study. Further, a limited number of missing values (four incidents) under the hospital performance indicators were excluded from the data.

5.6 Assessment of non-response bias

The study obtained a response rate of 36.31%. This allows a question to be raised. Will the group of non-respondents have answered the questionnaire differently? According to Lewis et al. (2013, p.330), '*Nonresponse bias in survey research can result in misleading or inaccurate findings, and assessment of nonresponse bias is advocated to determine response sample representativeness*.' Hence, non-response bias test was conducted considering the early and late respondents (Armstrong and Overton 1977). The valid sample for PLS-SEM was split into two groups based on the dates on which the responses were received to create early and late waves of respondents (Lambert and Harrington 1990). The first group was the responses that were received early in the first 6 weeks (57) and those received late in the last 6 weeks (44). It was presumed that the questionnaires returned late represented an approximation of non-respondents. Selecting the CSFs 'top management commitment' and 'Project Prioritisation selection, management, and tracking' the independent T-tests (pair-wise) using SPSS were conducted for the means of the two groups 0 and 1.

Group 0 represented the early responders and group 1 represented the late responders. As shown in the Tables in Appendix L, the results revealed no significant difference between the means of the two groups where the p-values (0.261, 0.826) were more than 0.05 and hence the null hypothesis (Stating the two means are equal) couldn't be rejected- no significant difference between the p-values of the two groups, which amounts to less than 0.05. Hence, the analysis indicated that there is no evidence of non-response bias in the data, and as a result, hereof, the sample is considered representative of the population.

5.7 Descriptive statistics and analysis of results

A brief description of the data received was conducted after completion of the main survey. SurveyMonkey and Excel graphing features were used to present and analyse results. In the questionnaire, certain questions were mandatory, as shown in Table 5.23 that also shows the number of responses received for each question.

The questionnaire contained 5 sections with 34 questions. The first part of the survey was dedicated to collecting information with regards to the demographics of the respondents.

Table 5.23: Questionnaire questions responses

Question #	Question topic	# Answers
1	Consent to participate*	260
2	Hospital Location	150
3	Number of full-time employees*	191
4	Hospital Type*	191
5	Number of patient beds*	191
6	Accreditation status of the hospital*	191
7	The extent of LSS implementation*	191
8	No deployment barriers	64
9	Number of years implementing or implemented LSS	122
10	Areas where LSS is/was implemented at	121
CSF Section		
11	Top management commitment*	101
12	Management of cultural change*	101

13	Availability of resources (financial, time)*	101
14	Linking LSS to customers*	101
15	Organisational infrastructure*	101
16	Aligning LSS projects to business objectives*	101
17	Linking LSS to suppliers*	101
18	Training and education*	101
19	Usage of problem-solving and Statistical thinking and tools*	101
20	Linking LSS to employees*	101
21	Understanding LSS methodology*	101
22	Incentive programme*	101
23	Communication of information*	101
24	Established Lean Six Sigma dashboard*	101
25	Attention question*	101
26	Project Prioritisation selection, management, and tracking*	101
27	Challenges for LSS implementation	99
Hospital performance indicators		
28_1	Outpatients' satisfaction has increased*	97
28_2	Lead-time for hospital services has decreased*	97
28_3	Employee satisfaction has increased*	97
28_4	The turnover rate of employees has decreased*	97
28_5	Productivity has improved*	97
28_6	The number of service defects, errors, or breakdowns has decreased*	97
28_7	The competitive position of the hospital has strengthened*	97
28_8	The waste in our operations and processes has been reduced*	97
29	Perception of LSS results*	97
CSF ranking		
30_1	Top management commitment	103
30_2	Management of cultural change	103
30_3	Availability of resources (financial, time)	103
30_4	Organisational infrastructure	103
30_5	Linking LSS to customers	103
30_6	Aligning LSS projects to business objectives	103
30_7	Linking LSS to suppliers	103
30_8	Training and education	103

30_9	Usage of problem-solving and statistical thinking tools	103
30_10	Linking LSS to employees	103
30_11	Understanding LSS methodology	103
30_12	Incentive programme	103
30_13	Communication of information	103
30_14	Established LSS dashboard	103
30_15	Project Prioritisation selection, management, and tracking	103
31	Future of LSS within the hospital	149
32	Hospital name	65
33	Name and contact details if interested to participate in the semi-structured interview	32
34	Email if interested to receive the consolidated results	66

*Mandatory question
Source: Author

The following sections provide the breakdown of the results.

5.7.1 Location of hospitals surveyed

From Figure 5.15, it would suffice to infer that the highest portion of the respondents come from hospitals located in Abu Dhabi (62.67%) followed by Dubai (30%). This outcome is evident, given that these are the two most abundant Emirates in the UAE, and most of the hospitals are located there. Further, the two Emirates were the recipient of most of the governmental funding. It was also noted that no responses were recorded from one of the seven Emirates in the UAE, i.e. Fujairah. Perhaps the respondents in that Emirates did not want to be identified.

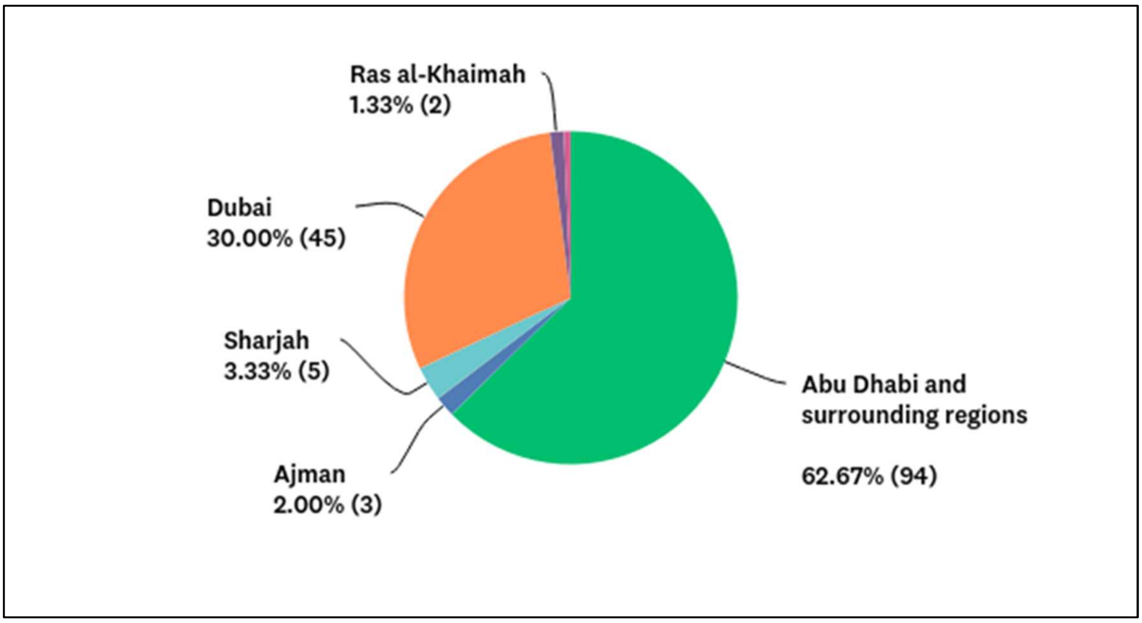


Figure 5.15: Breakdown of hospitals locations (N=150)
Source: Author

Figure 5.16 also shows the breakdown by location of respondents who indicated that their hospitals are implementing or have implemented LSS. As in the previous chart, the same percentage weights hold with 65.69% for Abu Dhabi and 30.39% for Dubai. Ras Al-Khaimah and Ajman Emirates' respondents indicated that they are not implementing LSS in their hospitals. However, since it is not possible to ascertain that the survey has reached every hospital in these 2 Emirates or if respondents elected not to answer this question, no conclusion can be made to rule out the deployment in these Emirates hospitals.

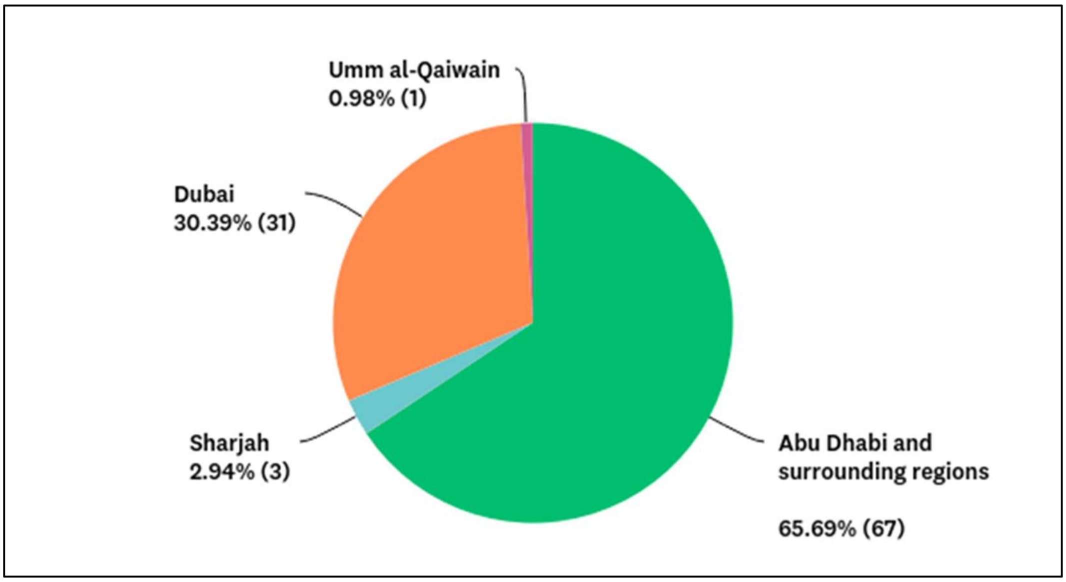


Figure 5.16: Respondents by hospital location who implements LSS (N=102)
Source: Author

5.7.2 Number of full-time employees

The findings showed that the majority of respondents worked for hospitals with full-time employees of more than 1000, as shown in Figure 5.17. Having enough resources in a hospital could be indicative of having ample resources for deployment.

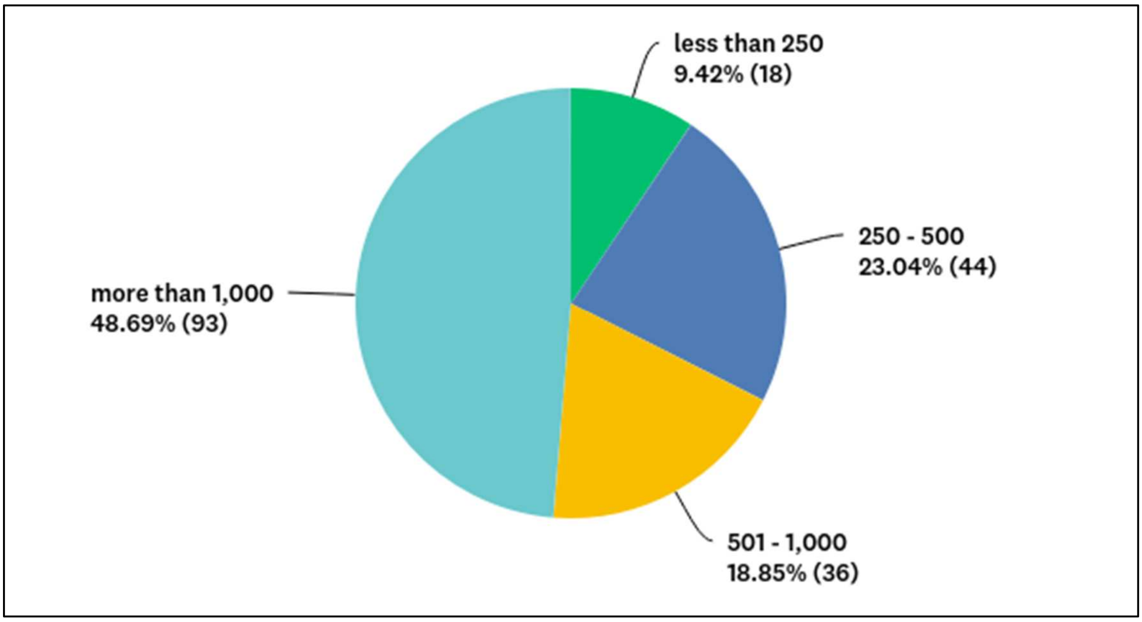


Figure 5.17: Number of full-time employees (N=191)
Source: Author

5.7.3 Type of hospital

The graph in Figure 5.18 shows the total respondents breakdown by hospital type where 42.93% works in governmental hospitals and 49.21% works in private hospitals.

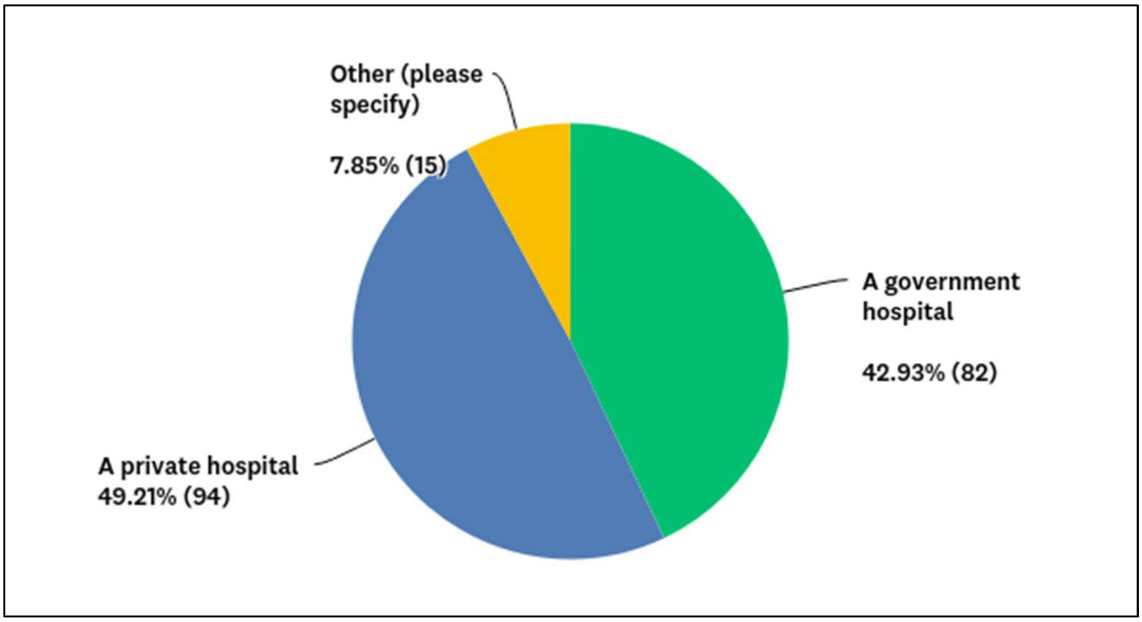


Figure 5.18: Type of hospital (N=191)
Source: Author

Table 5.24 shows the results for hospitals implementing LSS. The implementation of LSS in government hospitals was a bit higher when compared with private hospitals (49.1% vs 41.27%). Given the government policy to improve healthcare quality, it is not surprising that public hospitals showed the highest per cent of LSS implementation. The UAE government dominant strategy focuses on quality, its ambition to become a health tourist destination and priority to funds allocation to improve the healthcare processes are all drivers for adopting continuous improvement approaches and could also explain this higher percentage.

Table 5.24: Type of hospital that implements LSS

ANSWER CHOICES	RESPONSES	
A government hospital	49.21%	62
A private hospital	41.27%	52
Other (please specify)	9.52%	12
TOTAL		126

5.7.4 Number of patient beds

In this study, the number of patient beds was captured as part of the demographic variables. Using such data is helpful during data analysis and interpretation to better understand the outcomes. The number of patient beds could be an indication of the hospital size and its ability to allocate resources to enable the launch of LSS initiative where a hospital with more than 100 beds is considered large (Loux et al. 2005; Sjetne et al. 2007). More than 70% of the respondents indicated that their hospitals patient beds were above 100, as shown in Figure 5.19.

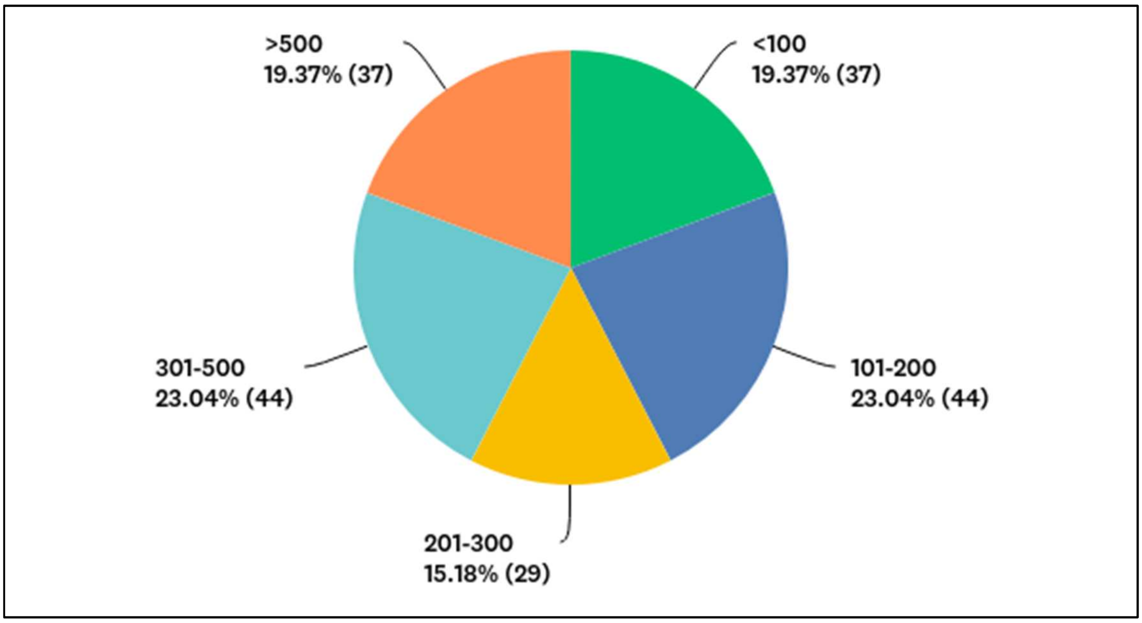


Figure 5.19: Number of patient beds (N=191)
Source: Author

Moreover, an examination of the breakdown of bed count in Table 5.25 for hospitals who implemented LSS draws a similar picture.

Table 5.25: Number of patient beds for hospitals which implemented LSS

ANSWER CHOICES	RESPONSES	
<100	14.29%	18
101-200	16.67%	21
201-300	15.08%	19
301-500	30.16%	38
>500	23.81%	30
TOTAL		126

5.7.5 Accreditation and certification status

The highest number of respondents who participated in the study indicated that their hospitals have Joint Commission International (JCI) accreditation, as shown in Figure 5.20. Some of these hospitals won local awards while others had the ISO9001 certification. It is noted that many hospitals reported that they had both JCI and ISO9001. It can be argued that the presence of quality accreditation/certification becomes a driver and enabler to pursue LSS as many of these frameworks encourage a culture of continuous improvement and allocation of trained resources to quality initiatives (Devkaran 2014; Devkaran and O'Farrell 2015).

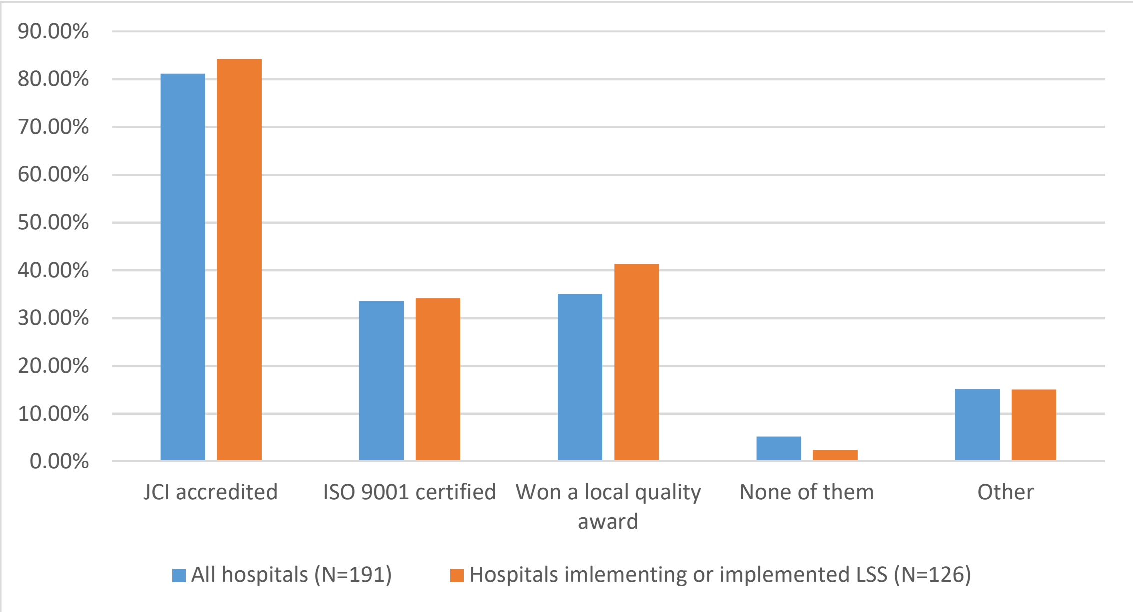


Figure 5.20: Accreditation and certification status
Source: Author

5.7.6 Status of LSS implementation

The results below in Figure 5.21 indicated that more than two-thirds of UAE hospitals implement some form of Lean, Six Sigma or LSS.

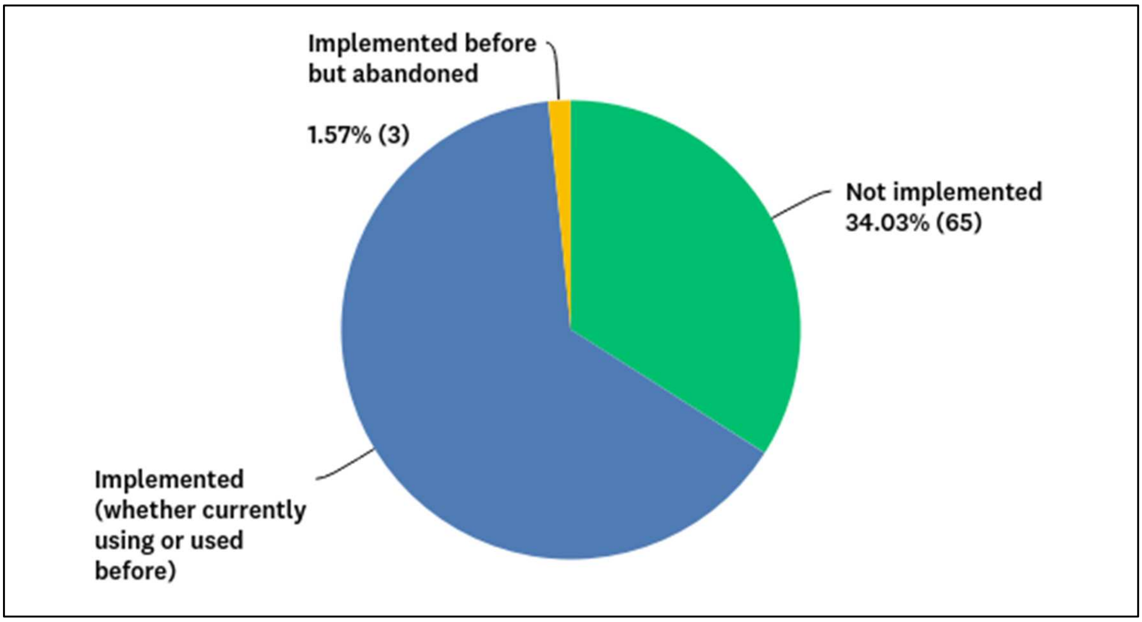


Figure 5.21: Status of LSS implementation (N=191)
Source: Author

5.7.7 Primary reason for not deploying LSS

This question targeted hospitals which reported that they do not implement LSS. The top three reasons for not deploying LSS in UAE hospitals were lack of leadership buy-in, lack of resources and lack of information to deploy (i.e. the Communication CSF) as shown in Figure 5.22 confirming previous studies (Albliwi et al. 2014). Narrative responses included the following comments: *'It is advanced', 'lack of motivation, responsibility and accountability of key players, 'lack of stability, and 'We believe that lean six sigma is not applicable in the medical field, because in health care facilities we are relay to the human interaction, hence lean six sigma will be successful in the organization rely on computerized system.'*

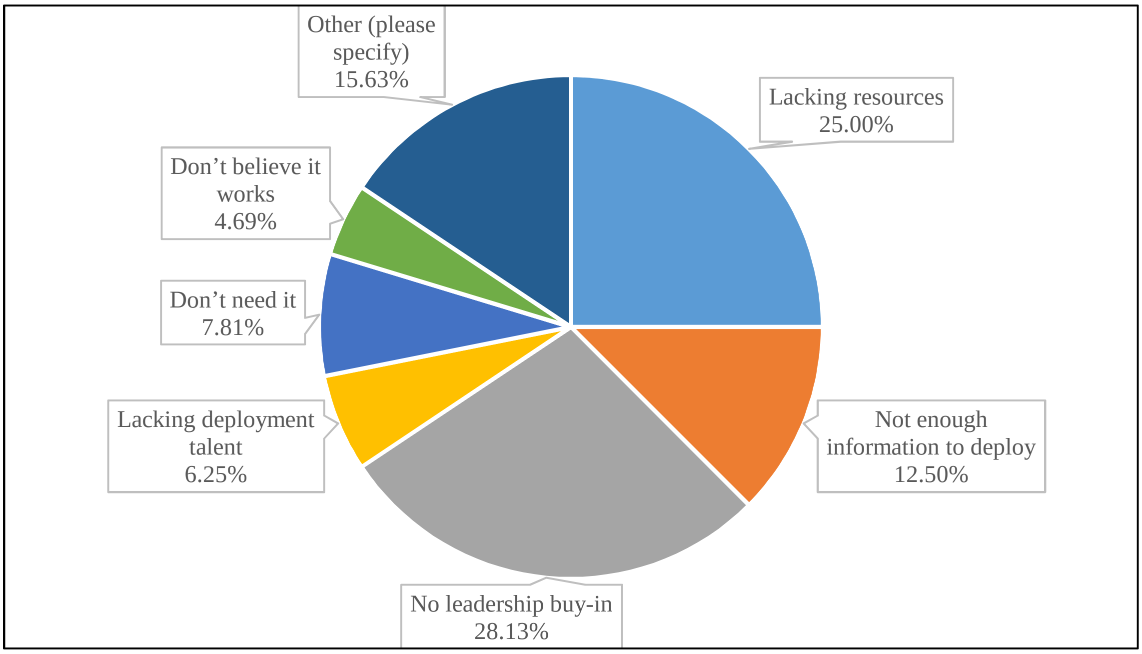


Figure 5.22: Primary reason for not implementing LSS (N=64)
Source: Author

5.7.8 Number of years deploying or have deployed LSS

Respondents in hospitals that were implementing/implemented LSS were asked about the number of years they have deployed LSS. Figure 5.23 shows that more than 85% of hospitals have recently started LSS deployment in the last 6 years. Only 9.84% reported that they have been implementing LSS between 7-9 years. A conclusion can be made that the majority of UAE hospitals started LSS implementation in the last 10 years. Given that Six Sigma started in the 1990s and Lean long before that, this could be an indication that LSS deployment in the UAE is still at its infancy compared with the grand scheme of quality improvement (e.g. ISO) in the UAE where it has implemented longer than 25 years. This finding was similar to Alsmadi et al. (2012) who investigated the implementation of Six Sigma in the neighbouring Kingdom of Saudi Arabia and reported that the majority of organisations started implementing Six Sigma in the last 1-7 years.

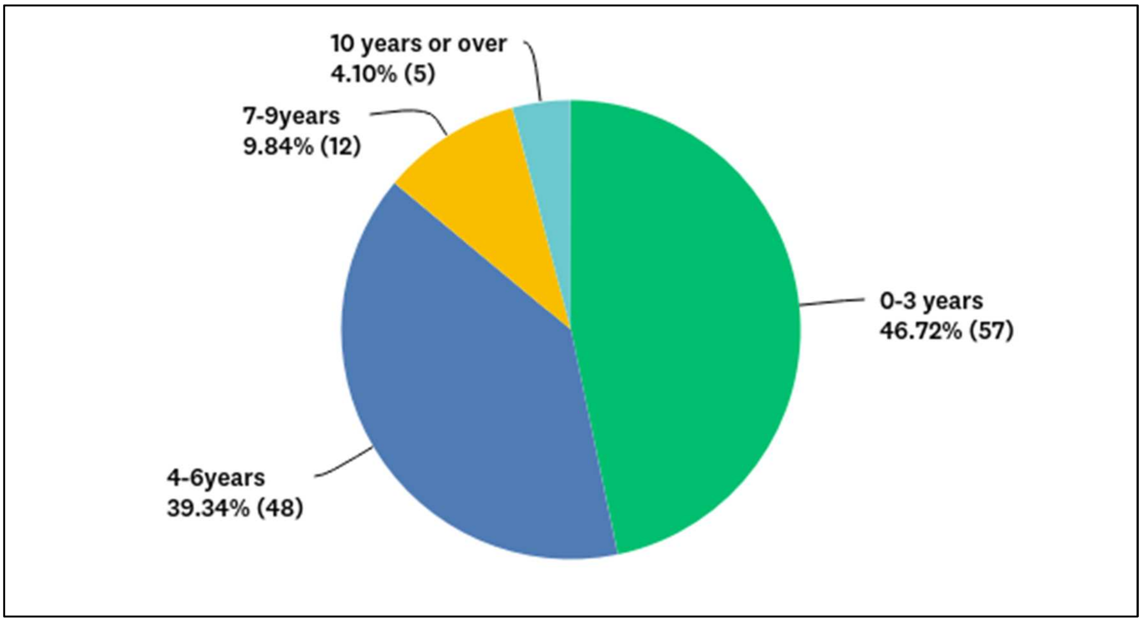


Figure 5.23: Number of years for LSS deployment (N= 122)
Source: Author

5.7.9 Hospital areas where LSS has been deployed at

Respondents in hospitals that implemented LSS indicated the areas where LSS has been implemented, as shown in Figure 5.24. The results confirm the findings in the literature (Antony et al. 2018) as most of LSS implementation was conducted at hospital operations (22.34%) followed by clinical (20.98%) and customer service (16.62%) areas. Other reported areas were Labs and quality control areas.

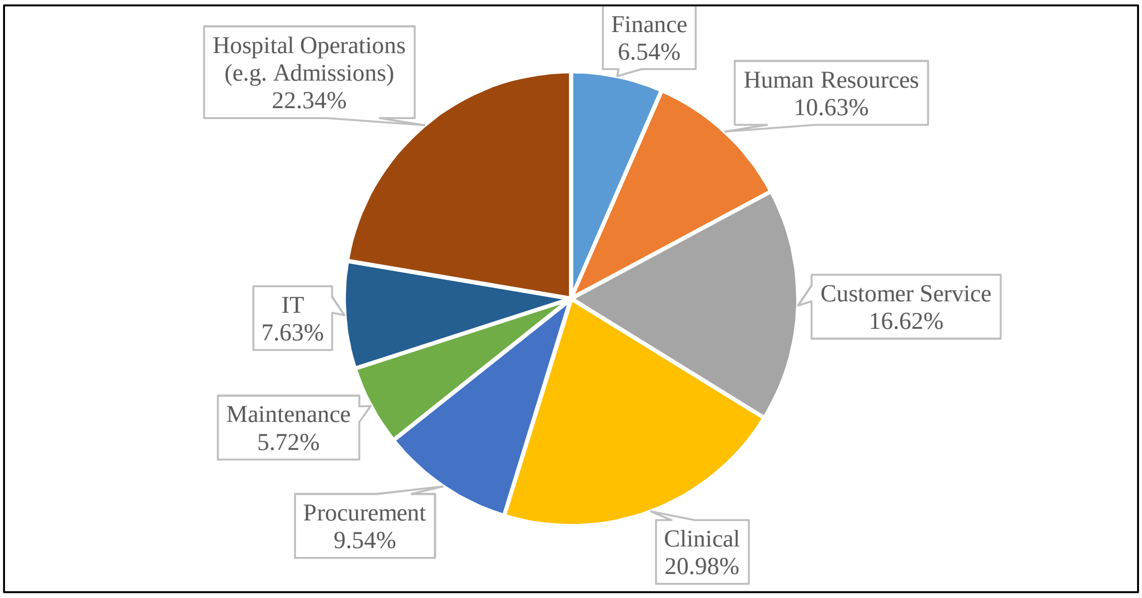


Figure 5.24: Areas where LSS is implemented (N=121)
Source: Author

5.8 Descriptive analysis of LSS CSFs

The following sections show the descriptive results of respondents' responses describing the extent to which the CSFs are observed towards LSS deployment in UAE hospitals. The Tables in Appendix M show the detailed frequency and percentages for the answers, while Figure 5.25 shows the weighted average for each of the CSFs based on the views of respondents at hospitals which are implementing LSS. The author decided to consider a threshold of 80% agreement (sum of strongly, moderately and mildly agree) as being significant (Following the 80/20 rule) while any CSF that scored less than 80% was considered a problematic area. From a macro point of view, the top 5 existing CSFs were linking LSS projects to customers and patients, visible top management commitment, aligning LSS projects to business objectives, training and education and usage of problem-solving and statistical thinking tools. The less observed practices towards LSS were the availability of resources, incentive programmes, organisational infrastructure, linking LSS to suppliers and communication of information.

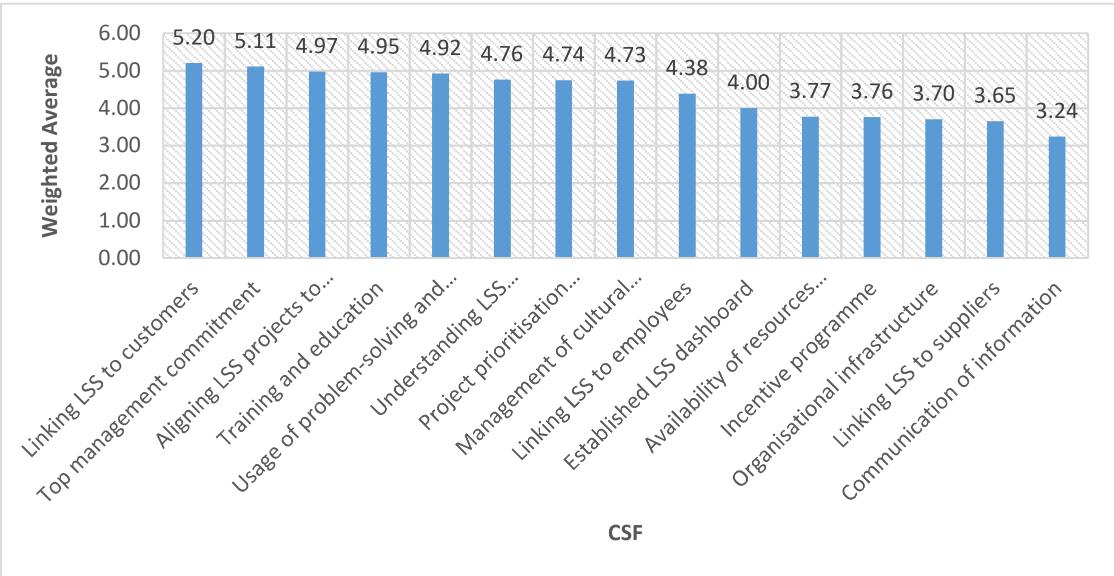


Figure 5.25: The extent of CSF in UAE hospitals (N=101)
Source: Author

5.8.1 Top Management commitment

The results confirmed previous research that this top management commitment is one of the top critical enablers for LSS deployment (Laureani and Antony 2012; Laureani and Antony 2016). A high percentage of respondents agreed (Strongly agree (46.53), moderately agree (31.68) and mildly agree (13.86)) that top management practices towards LSS existed in their hospitals as shown in Figure 5.26.

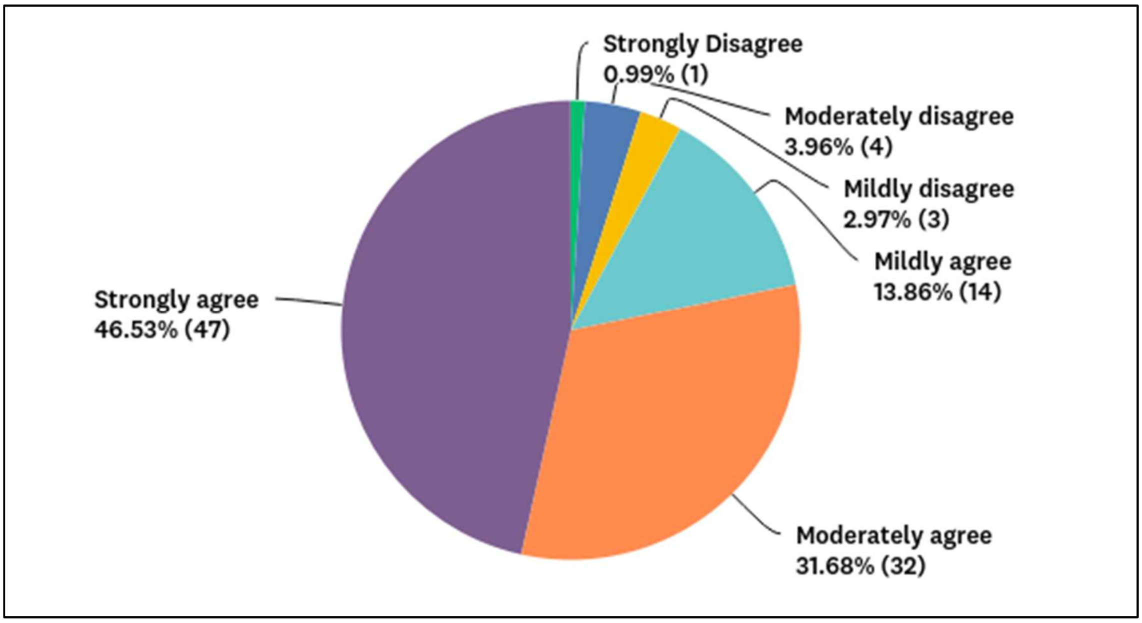


Figure 5.26: Top management commitment (N=101)
Source: Author

5.8.2 Management of cultural change

Respondents mostly agreed that their hospitals are adaptive to change (Strongly agree (23.76), moderately agree (40.59) and mildly agree (25.74)) as shown in Figure 5.27. This is a positive indicator that explained why many UAE hospitals are ready to deploy LSS initiatives amidst suitable conditions.

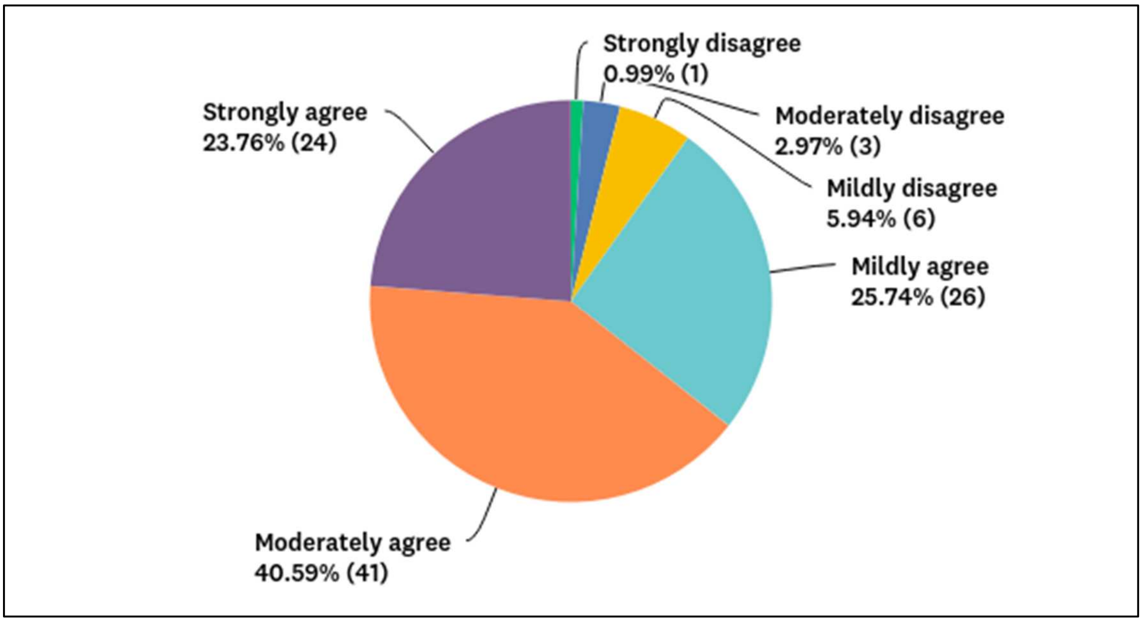


Figure 5.27: Management of cultural change (N=101)
Source: Author

5.8.3 Availability of resources (financial, time, etc..)

There was a mix of answers to this question. Broadly speaking, respondents disagreed that LSS programme was getting the needed resources (Strongly disagree (12.87), moderately disagree (4.95) and mildly disagree (16.83)) as shown in Figure 5.28 . This could be due to lack of management buy-in and understanding of the benefits of LSS. This can be a serious issue for implementation and need to be addressed by UAE hospitals.

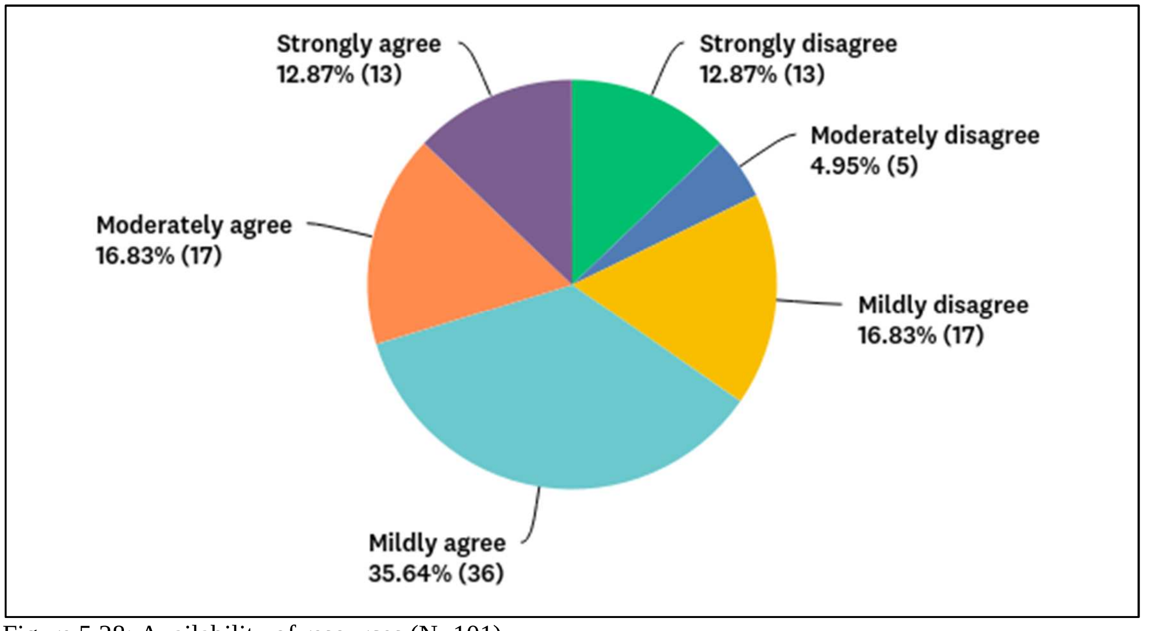


Figure 5.28: Availability of resources (N=101)
Source: Author

5.8.4 Linking LSS to patients and customers

This factor scored the highest in terms of the agreement percentage, where the agreement percentage was above 95%, as shown in Figure 5.29. This is a good indication that UAE hospitals are focusing on their patients/customers and hence methodologies like LSS, that mainly focus on the voice of the customer, will be very appropriate and well supported by this mindset.

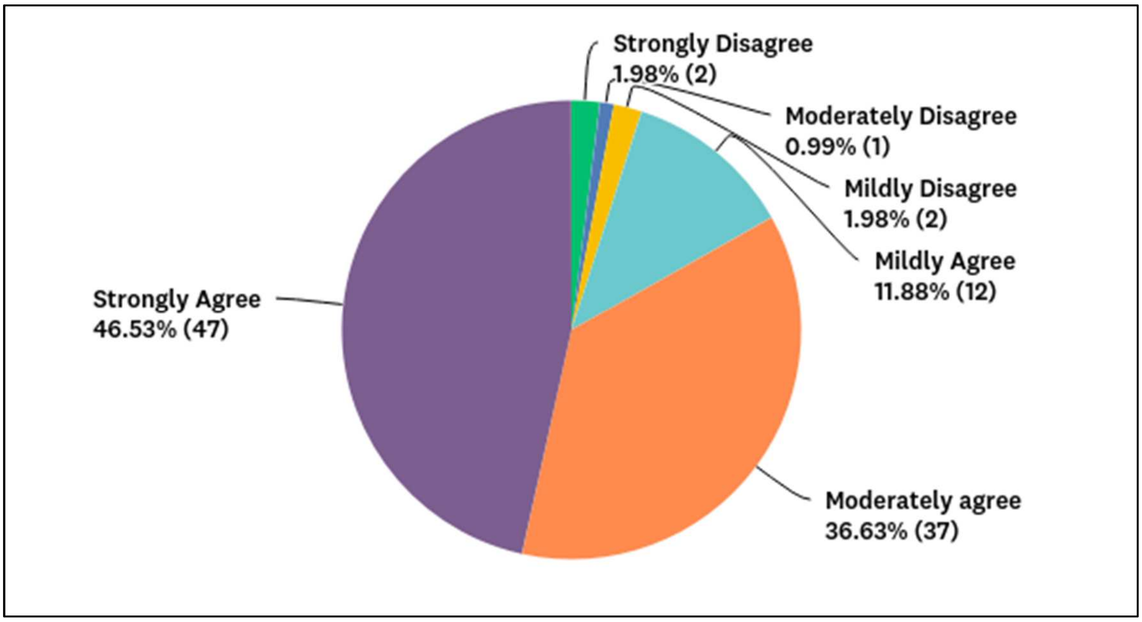


Figure 5.29: Linking LSS to customers (N=101)
Source: Author

5.8.5 Organisational infrastructure

A closer inspection of the results in Figure 5.30 showed that this is a concern area for the respondents where they reported weakness when it comes to organisational infrastructure (e.g. collaboration of cross-functional teams)

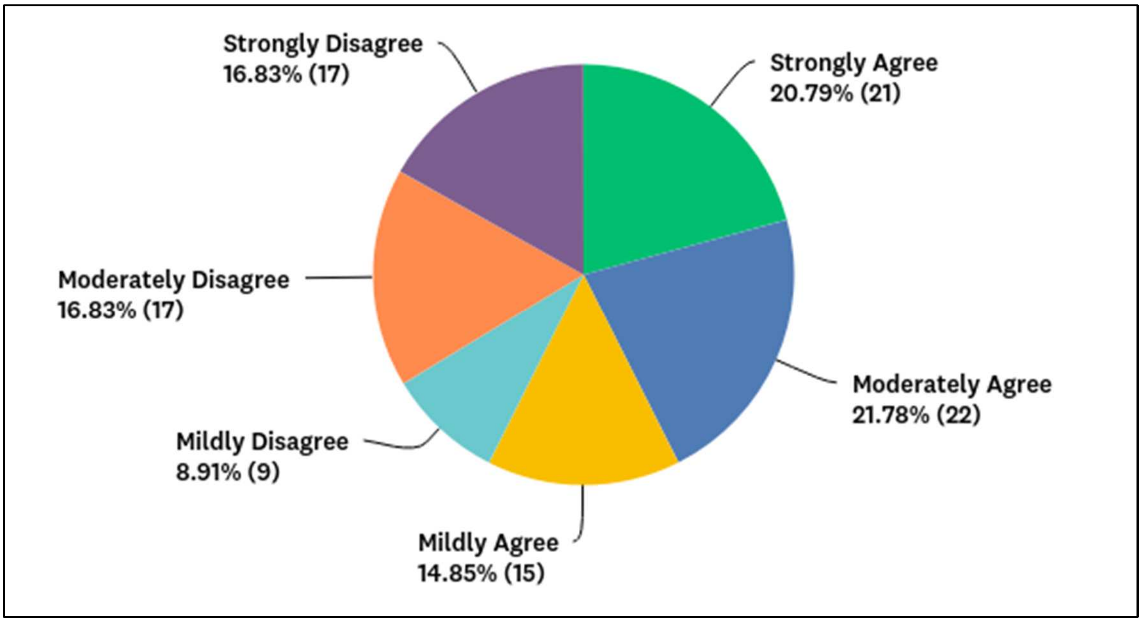


Figure 5.30: Organisational infrastructure (N=101)
Source: Author

5.8.6 Aligning LSS projects to business objectives

It is apparent from Figure 5.31 that the majority of the respondents agreed that this practice exists in their hospitals where improvement projects such as LSS are aligned with business strategy and objectives. Linking LSS projects to strategic objectives becomes an enabler to LSS deployment where top management can realise the value of running these LSS projects to support the achievement of the organisation strategy.

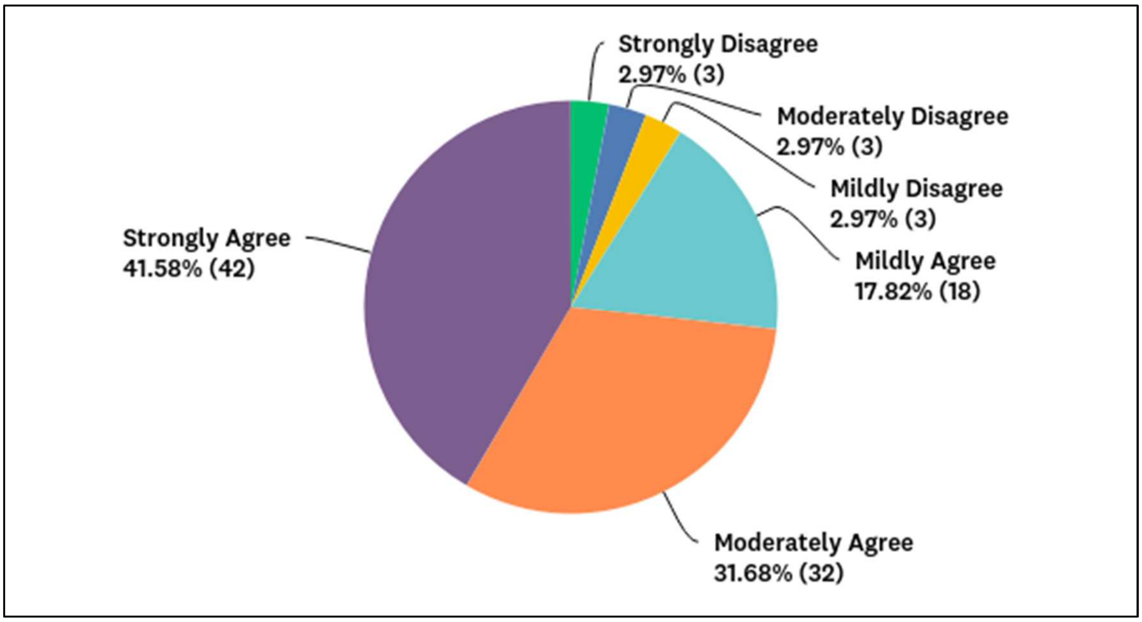


Figure 5.31: Aligning LSS projects with business objectives (N=101)
Source: Author

5.8.7 Linking LSS to suppliers

Figure 5.32 illustrates that 45% of the respondents reported a weakness in this area where they thought that their hospitals are not working well with their suppliers when it comes to LSS deployment. Many argue that working with suppliers to improve the process capability of supply chain operations is critical to organisational success. Hence, the notion of involving suppliers in Six Sigma projects and selecting suppliers who have implemented Six Sigma becomes a factor for LSS successful deployment (Desai et al. 2012).

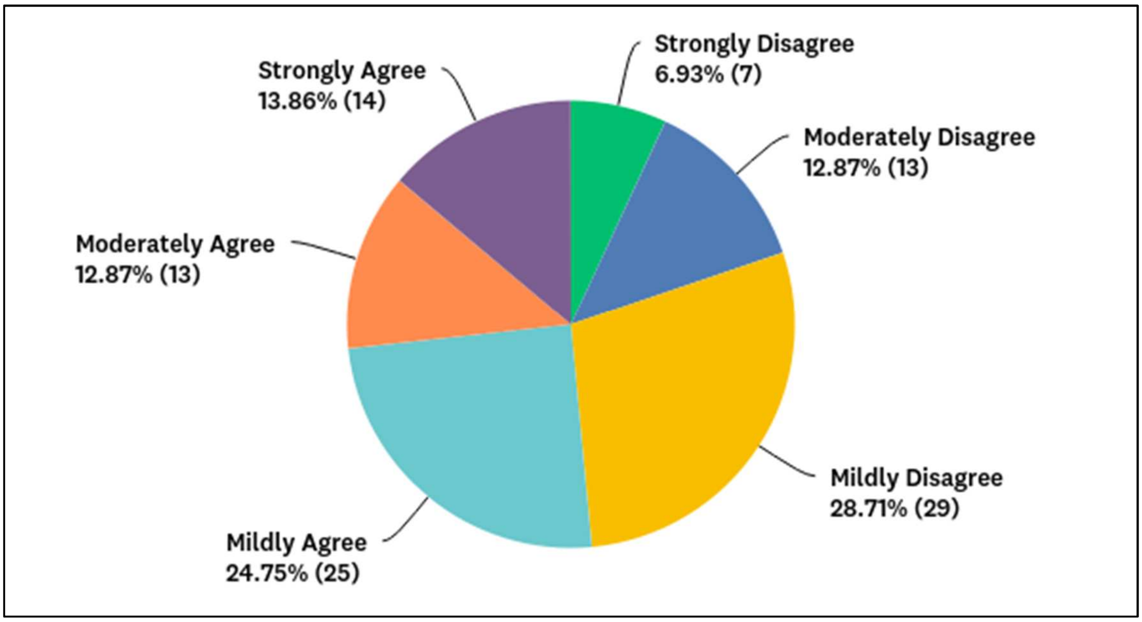


Figure 5.32: Linking LSS to suppliers (N=101)
Source: Author

5.8.8 Training and education

As shown in Figure 5.33, most of the respondents agreed that their hospitals are providing suitable training and education towards improvement initiatives and LSS. One should note that training and education is a continuous process and not a one-time exercise. This factor is critical to the success of LSS, where the training of staff and specialised personnel (The belt holders) becomes critical to LSS deployment. Furthermore, the selection of team members for LSS projects and the content of the training programmes should be carefully considered (Antony and Gupta 2018).

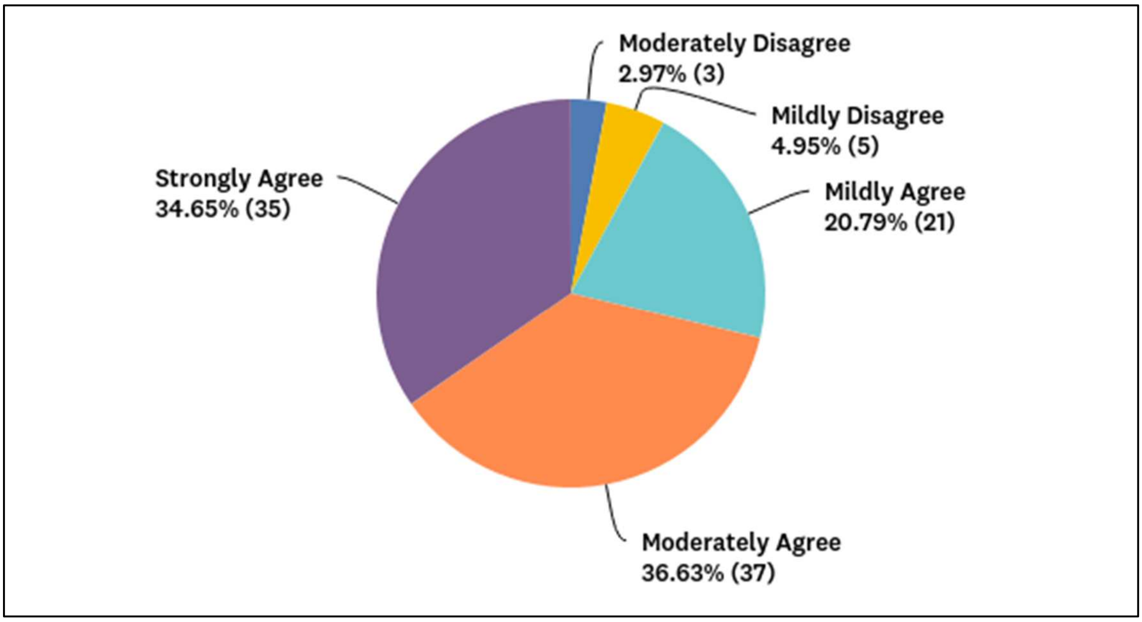


Figure 5.33: Training and education (N=101)
Source: Author

5.8.9 Usage of problem-solving and statistical thinking and tools

Figure 5.34 illustrates that many respondents agreed that the use of problem-solving and statistical thinking tools was quite supported and visible at their hospitals.

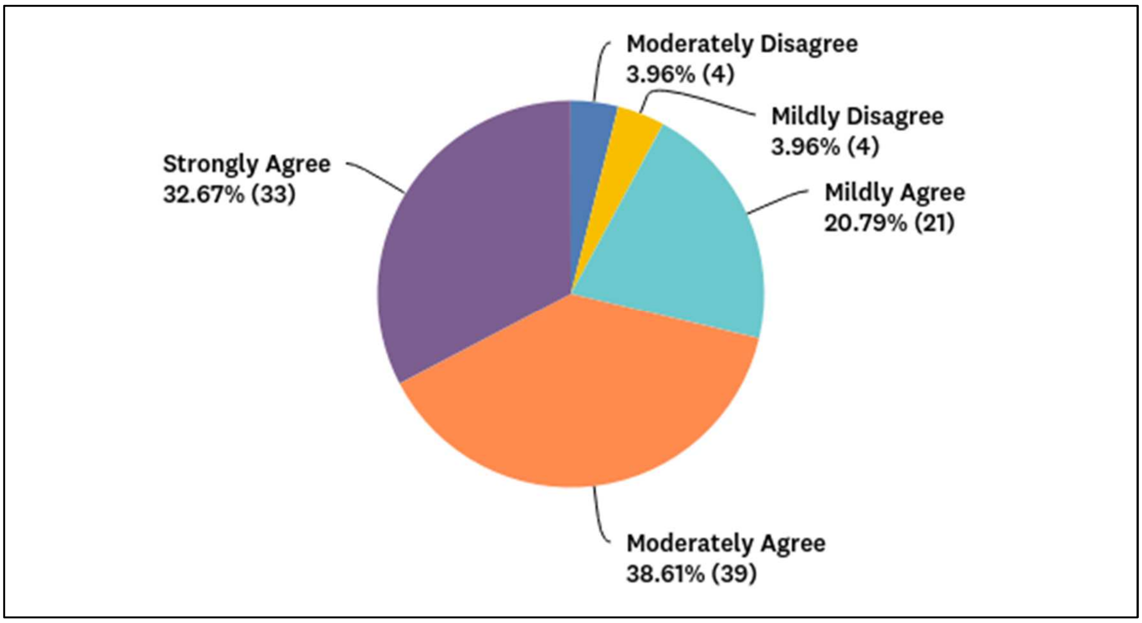


Figure 5.34: Usage of problem-solving and statistical thinking and tools (N=101)
Source: Author

5.8.10 Linking LSS to employees

Most of the respondents agreed, as shown in Figure 5.35, that their hospitals are providing enough awareness to their employees to understand the benefits of LSS, how it relates to their jobs and linking that to employee performance systems.

Getting the buy-in and the understanding of employees to support the deployment of continuous improvement initiatives is critical to success. It is suggested to use Six Sigma accomplishments as the key measure for management performance and compensation, make Six Sigma training mandatory for promotion consideration and to award monetary bonuses based on the successful implementation of Six Sigma projects (Desai et al. 2012).

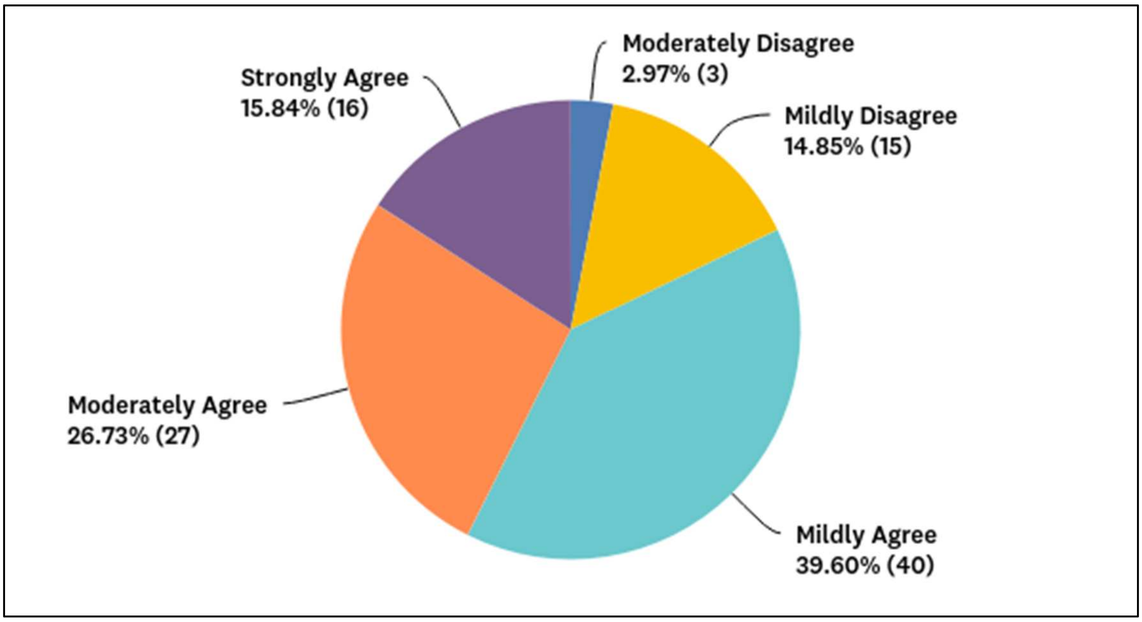


Figure 5.35; Linking LSS to employees (N=101)
Source: Author

5.8.11 Understanding LSS methodology

Figure 5.36 shows that respondents reported a high agreement that there is a support to this practice at their hospitals. The understanding of how the LSS methodology (DMAIC) operates and what are the specific phases and tools that have to be used is a critical component in deployment. The lack of awareness or understanding both at the levels of top management and employees could undermine the whole deployment process and could become a significant barrier (Antony and Kumar 2012).

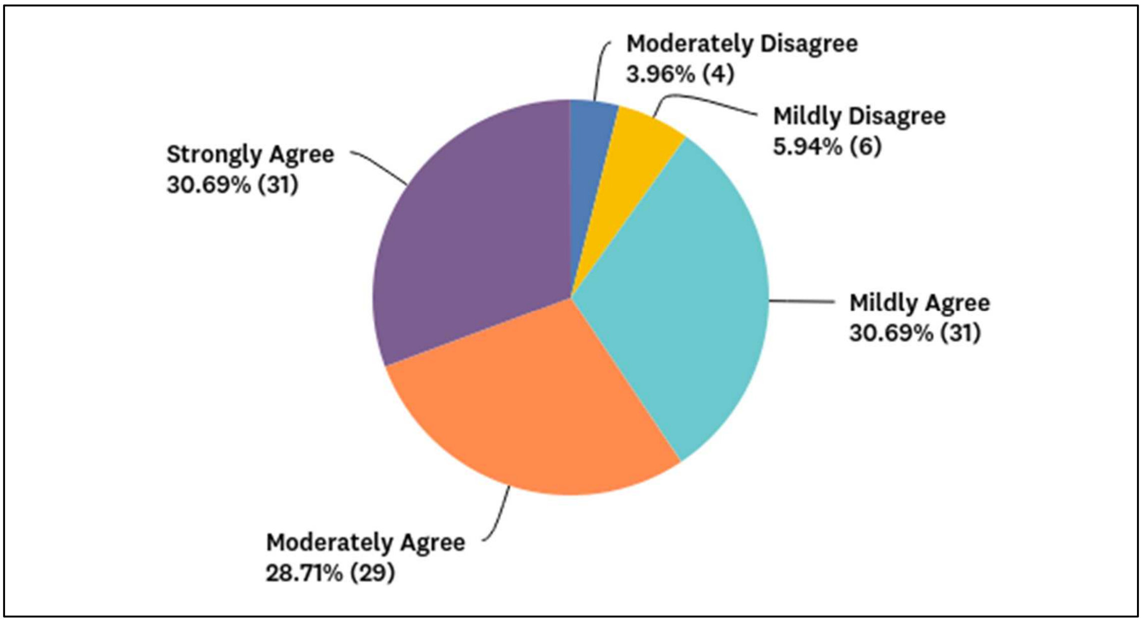


Figure 5.36: Understanding LSS methodology (N=101)
Source: Author

5.8.12 Incentive programme

As shown in Figure 5.37, respondents reported a weak presence of this factor. Hence, reviewing and updating the current human resources systems to incorporate this critical element towards LSS should become a priority for UAE hospitals. It is argued that rewards and recognition provide motivation, support, and boost staff morale, which in turn will enhance their productivity and performance. Such an environment can be supportive of LSS deployment (Antony and Gupta 2018). Employees who participate in LSS deployment and projects should be incentivised accordingly.

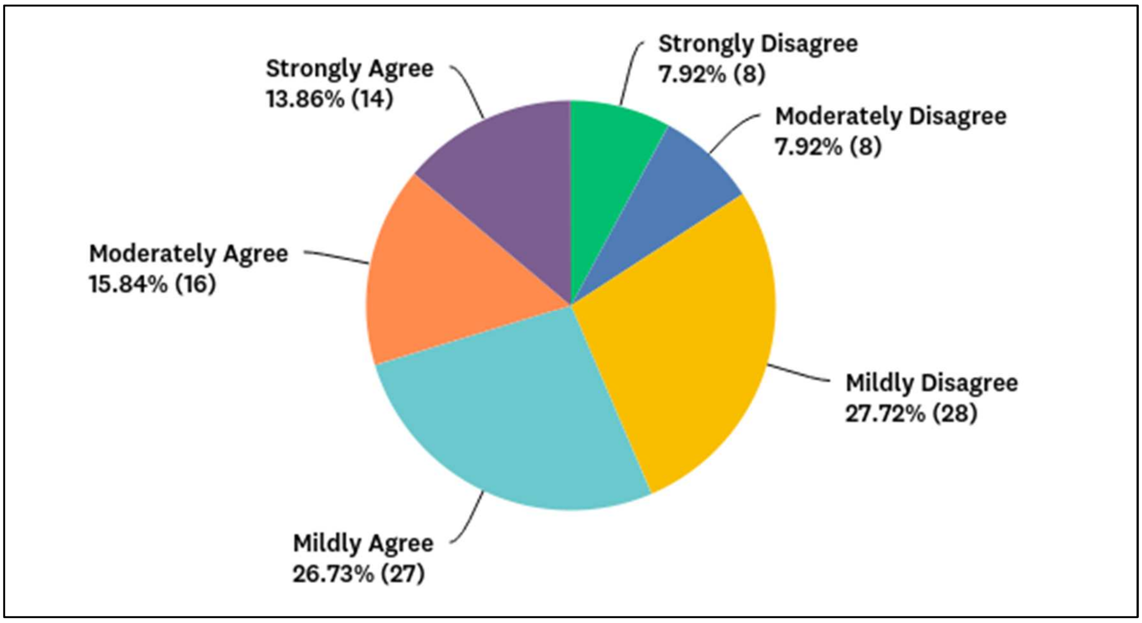


Figure 5.37: Incentive programme (N=101)
Source: Author

5.8.13 Communication of information

From the data in Figure 5.38, it can be shown that respondents reported weak communication of LSS information at their hospitals. This is another area of concern and must be addressed by the top management. Communication is required to initiate cultural change through frequent communication to the organisation's staff on the benefits of LSS and the status of projects. For example, early and effective communication on the why and how of Six Sigma will be critical to its success. Moreover, explaining the difference between Six Sigma and other quality improvement initiatives and demonstrating the need for Six Sigma in terms of benefits to the employees ,will support the involvement and buy-in of both top management and staff (Desai et al. 2012). One can argue that poor communication may cause the teams to lose momentum and interest in maintaining LSS.

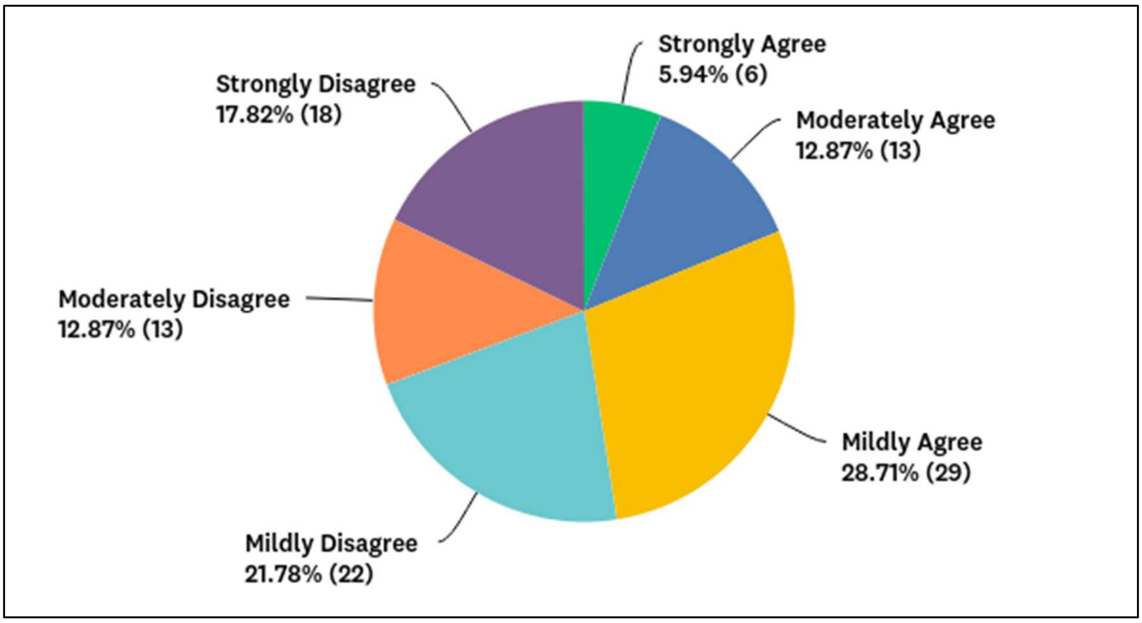


Figure 5.38: Communication of LSS information (N=101)
Source: Author

5.8.14 Established LSS dashboard

Most of the respondents did not agree that this practice is being implemented at their hospitals, as shown in Figure 5.39. Business practitioners argue that it is hard to manage and improve what you do not measure. Therefore, LSS activities should be integrated into organisational measures and tracked through scorecards or dashboards. Clear goals and targets should be identified in a dashboard that is linked to business performance and customer needs.

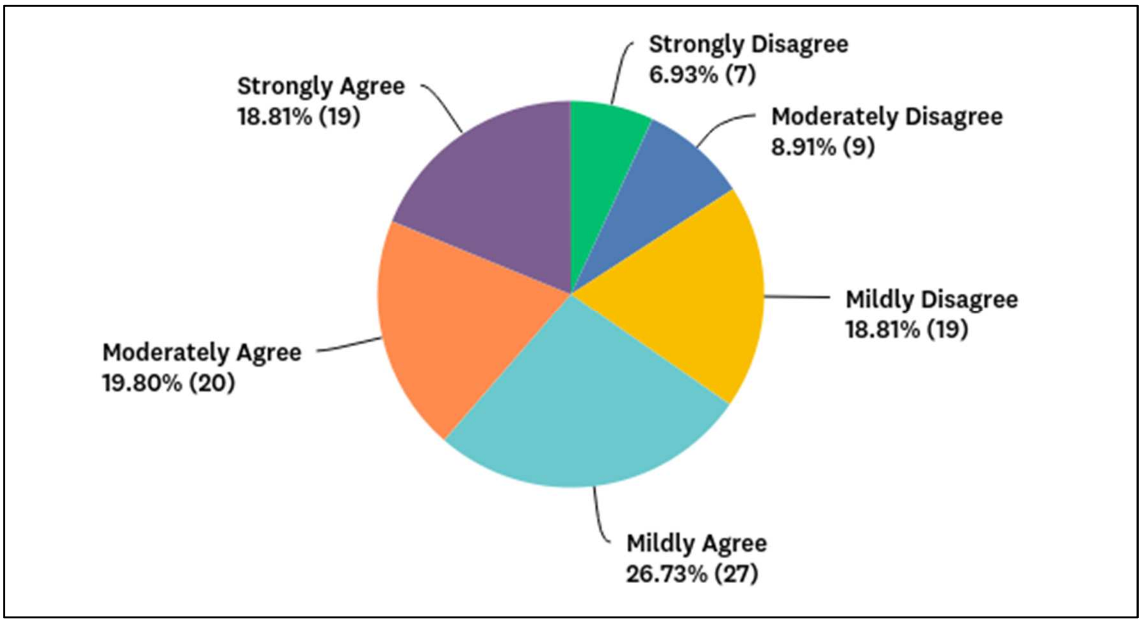


Figure 5.39: LSS dashboard (N=101)
Source: Author

5.8.15 LSS Project prioritisation, selection, management and tracking

When LSS projects are selected, a careful review is conducted to make sure that projects are linked to organisational strategy, has a link to customer needs, has a financial impact and feasible in terms of collecting data and completing it within a reasonable time frame. This practice includes developing project management skills for LSS staff to enable the tracking of the projects. As shown in Figure 5.40, the majority of the respondents agreed that their hospitals are doing a good job in selecting LSS projects.

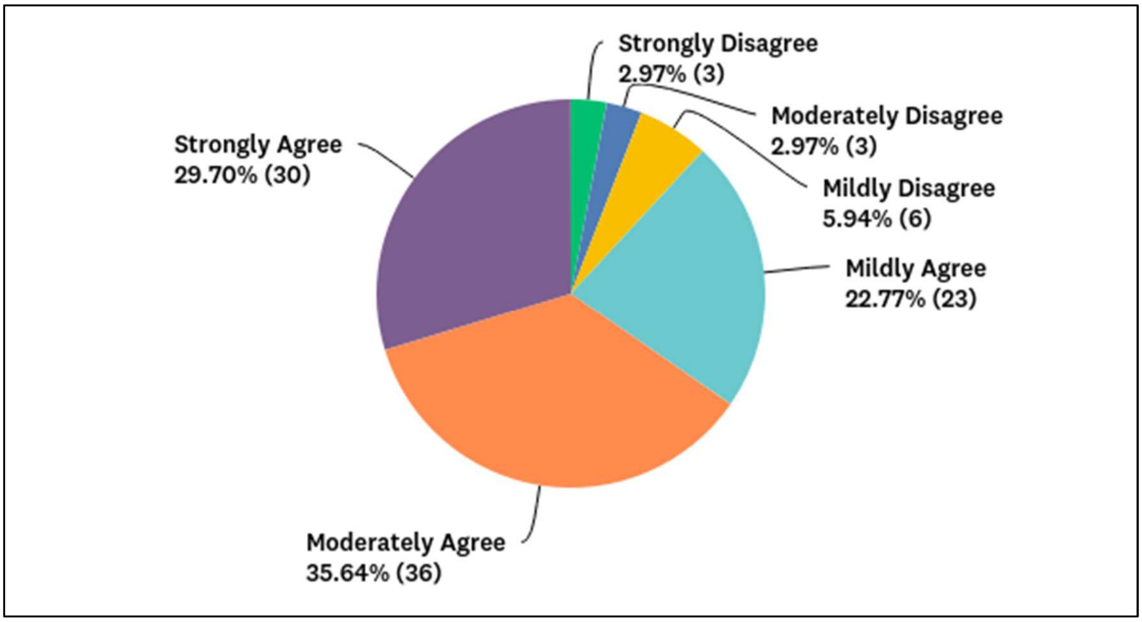


Figure 5.40: Project Prioritisation selection, management and tracking (N=101)
Source: Author

5.9 Challenges for LSS implementation

Respondents were asked about the challenges for LSS implementation at their hospitals (This question allowed multiple responses). As shown in Figure 5.41, respondents indicated that the top challenges for implementing LSS are lack of resources, internal resistance, change of management (Which will result in lower management support), inadequate training and coaching and competing projects.

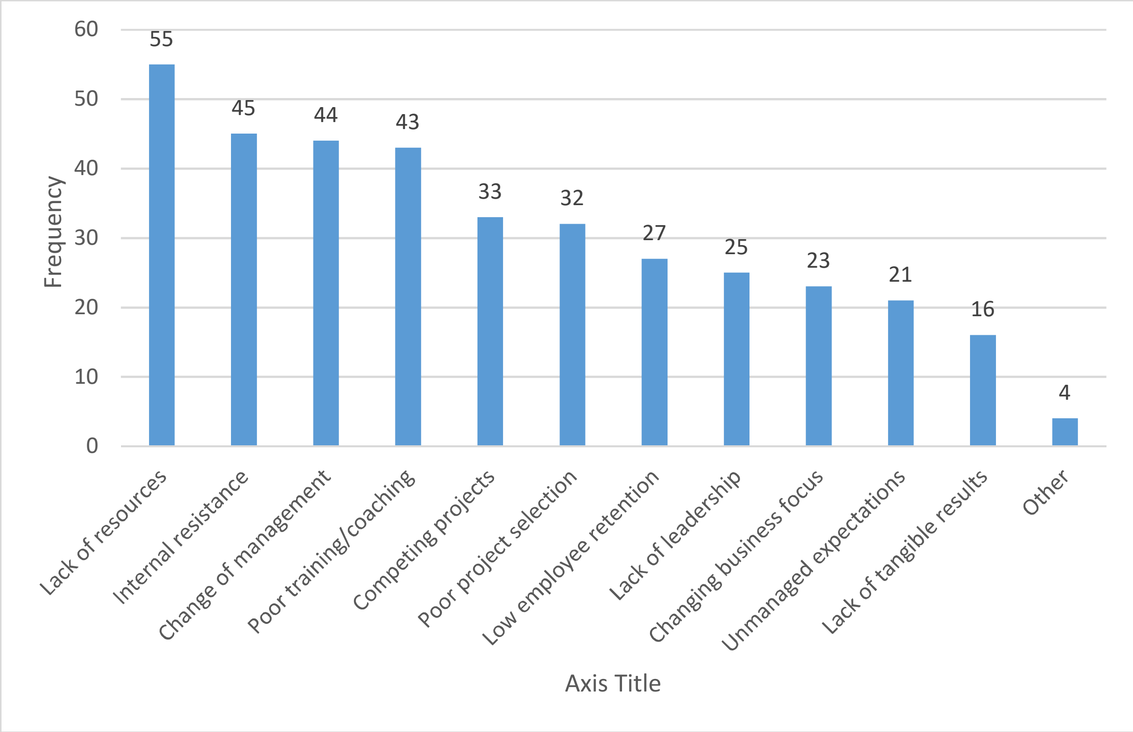


Figure 5.41: Challenges for LSS implementation (N=99)
Source: Author

Not surprisingly, these findings are consistent with previous research conducted in similar GCC countries (Alsmadi et al. 2012; Albliwi et al. 2017). For example, Albliwi et al. (2017) reported that following barriers for Saudi Arabia organisations: time-consuming, lack of leadership, lack of awareness of LSS benefits to the business, convincing top management and internal resistance.

Other areas mentioned by respondents are quoted as follows *'Poor implementation'*, *'Projects that are too complex'*, *'(Lack) of ownership of project leadership'*, *'We have most of these projects done with the operational level, done individually without integrated approach'*, *'we lack management and leadership buy-in and 'Lack of awareness of the benefits of Six Sigma.'*

5.10 Hospital performance indicators

An emerging trend with LSS studies is the investigation of the impact of LSS implementation on organisational performance and highlighting its benefits (Teo 2010; McDonald and Kirk 2013; Antony et al. 2018; Shafer and Moeller 2012; Lamine and Lakhal 2018; Antony and Kumar 2012). The common areas that are currently measured in hospitals are related to customer or patient focus, financial improvement, operation excellence, people, and compliance (Antony et al. 2018). In their comprehensive review of LSS papers, the authors listed the top five benefits that could be translated into indicators. These include patient satisfaction, process speed (reduction of process cycle time), revenue enhancement, cost savings, and defect reduction, respectively). Although these top five benefits account for 68% of the total benefit categories, their ranking was found to vary between the six continents in the study (Antony et al. 2018).

In this study, the respondents were asked to indicate their perception of 8 hospital performance indicators adopted from the literature. From a macro point of view with regards to the most impacted hospital performance indicators in UAE hospitals, the highest 3 areas were; waste reduction in operations, reduction in the number of service defects and errors followed by productivity increase. What also stands out in the results, is that both indicators relating to the impact of LSS on employees perspective scored the lowest. This may be explained by the fact that UAE has around 85% expatriate population that exhibits continuous staff turnover seeking better pay and job opportunities.

The following sections show a descriptive analysis of the responses. Table 5.26 shows the detailed frequency and responses agreement per cent, while Figure 5.42 illustrates the weighted average of the scores.

Table 5.26: Hospital performance indicators results

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Outpatients' satisfaction has increased	1.03%	3.09%	5.15%	25.77%	38.14%	26.80%		
	1	3	5	25	37	26	97	4.77
Lead-time for hospital services has decreased	1.03%	1.03%	7.22%	28.87%	37.11%	24.74%		
	1	1	7	28	36	24	97	4.74
Employee satisfaction has increased	1.03%	10.31%	11.34%	40.21%	20.62%	16.49%		
	1	10	11	39	20	16	97	4.19
The turnover rate of employees has decreased	5.15%	10.31%	30.93%	34.02%	13.40%	6.19%		
	5	10	30	33	13	6	97	3.59
Productivity has improved	0.00%	3.09%	5.15%	26.80%	37.11%	27.84%		
	0	3	5	26	36	27	97	4.81
Number of service defects, errors, or breakdowns has decreased	0.00%	2.06%	8.25%	23.71%	36.08%	29.90%		
	0	2	8	23	35	29	97	4.84
The competitive position of the hospital has strengthened	0.00%	3.09%	17.53%	24.74%	30.93%	23.71%		
	0	3	17	24	30	23	97	4.55
The waste in our operations and processes has been reduced	0.00%	3.09%	6.19%	20.62%	41.24%	28.87%		
	0	3	6	20	40	28	97	4.87

Source: Author

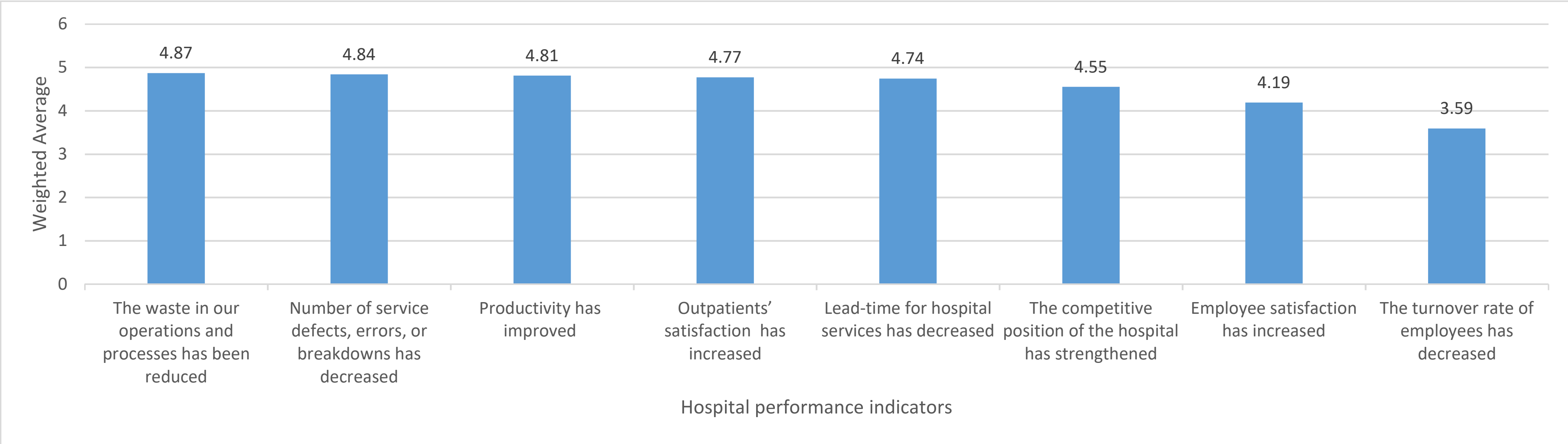


Figure 5.42: Weighted average of hospital performance indicators (N=97)
Source: Author

5.10.1 Outpatients' satisfaction

One of the key objectives of any continuous improvement initiative is to enhance customer satisfaction. When LSS is correctly deployed in hospitals, it is expected to have an impact on this indicator. The majority of respondents in hospitals that have implemented LSS indicated that LSS had a positive impact on patients satisfaction. This is shown in Figure 5.43.

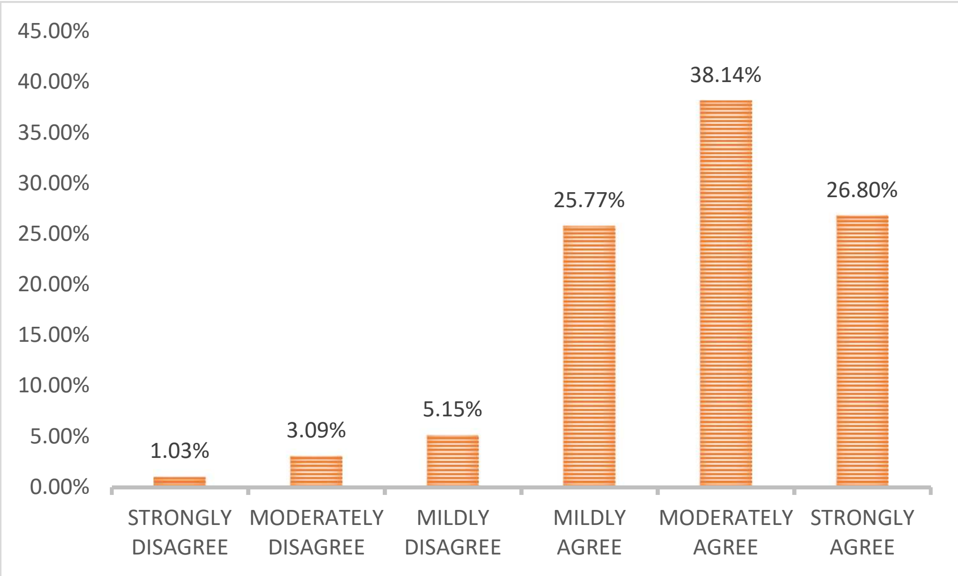


Figure 5.43: Outpatients' satisfaction (N=97)
Source: Author

5.10.2 Lead-time for hospital services

Another main benefit from continuous improvement initiatives such as LSS is the impact on services lead time. As mentioned before, process speed (reduction of process cycle time) is an expected benefit when implementing LSS in healthcare (Antony et al. 2018). The majority of respondents in hospitals that have implemented LSS indicated that LSS had a positive impact on lead time for hospital services. This is shown in Figure 5.44.

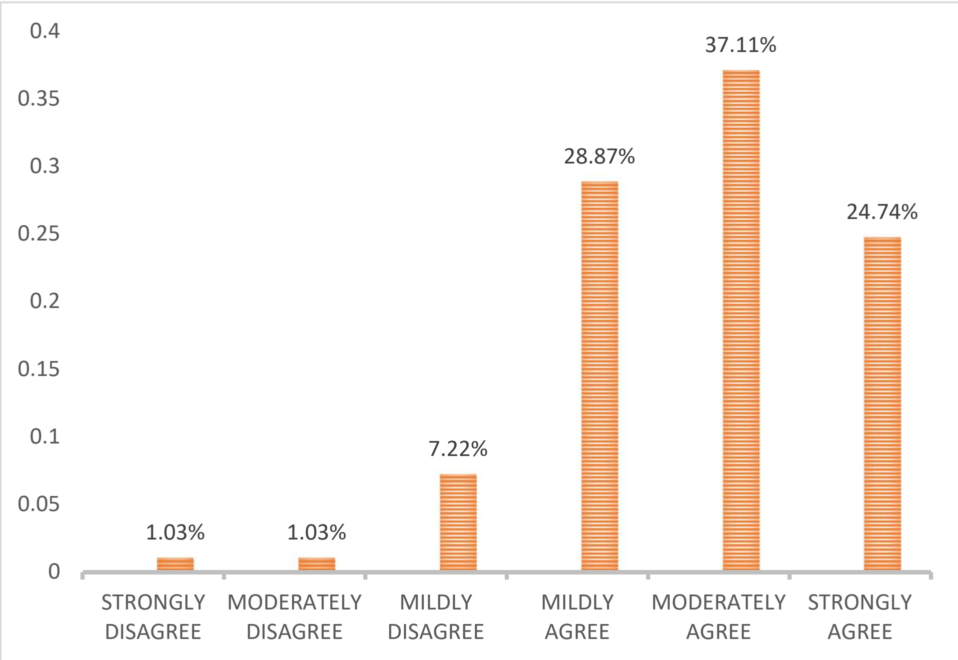


Figure 5.44: Lead-time for hospital services (N=97)
Source: Author

5.10.3 Employee satisfaction

Being able to participate in improvement projects, initiate change and get recognised increases staff motivation as argued by Antony and Kumar (2012) who studied LSS implementation in NHS Scotland. In this study, the agreement percentage is not considered high for this indicator, shown in Figure 5.45. This result raises concerns on the level of staff engagement within continual improvement initiatives and whether they feel there is a benefit for them. i.e. 'What's in it for me' factor.

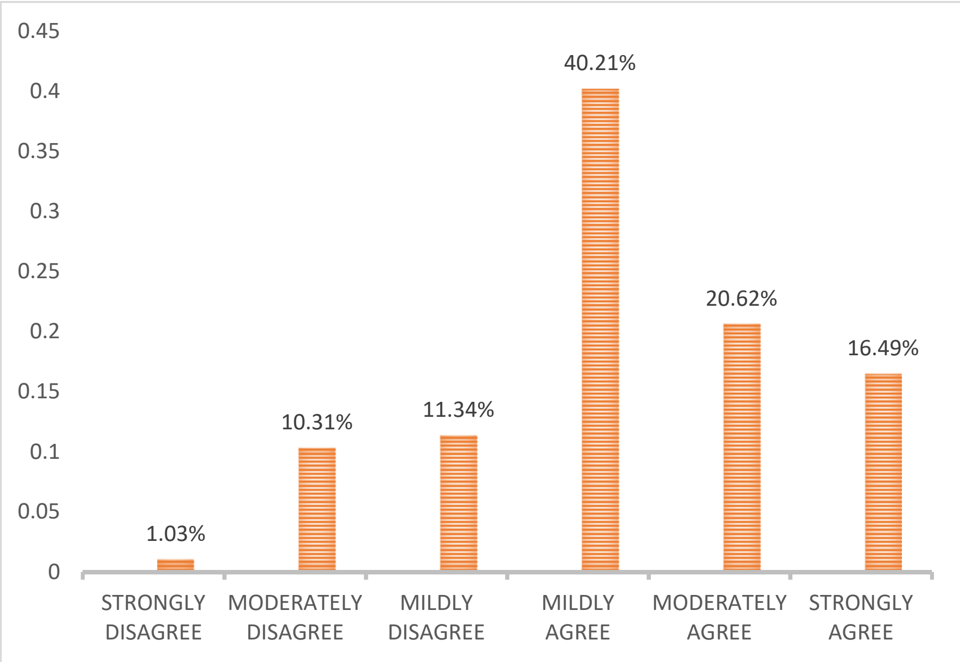


Figure 5.45: Employee satisfaction (N=97)
Source: Author

5.10.4 Turnover rate of employees

This indicator scored the lowest by respondents, as shown in Figure 5.46. The issue of turnover in GCC countries is a complex one, and one needs to consider other factors, including the transient nature of GCC jobs and how expatriates continuously move in and out of this region.

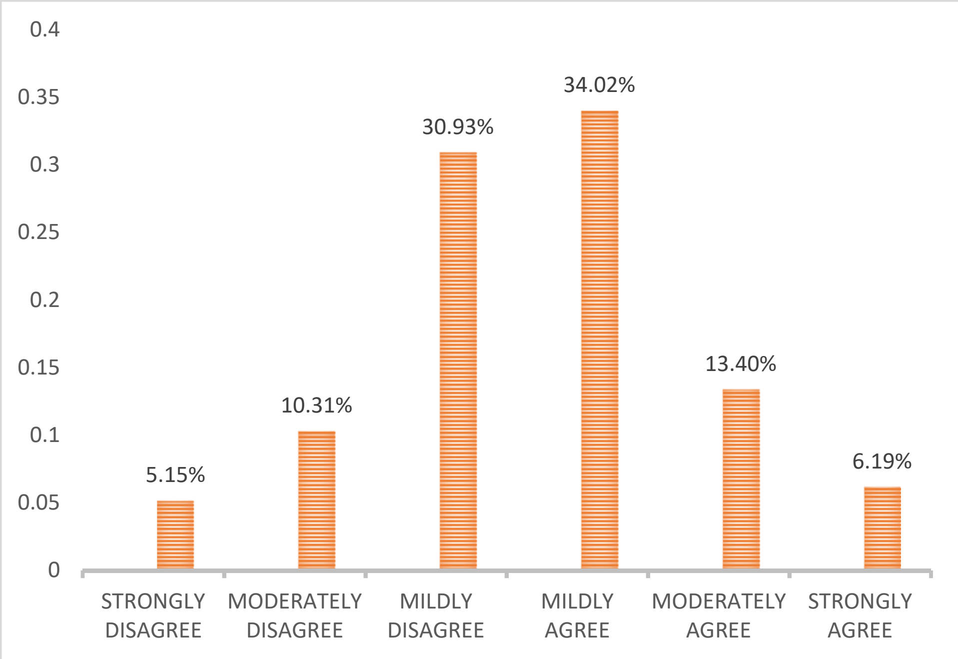


Figure 5.46: Employee turnover (N=97)
Source: Author

5.10.5 Productivity

When asked if LSS implementation improved operations with no increase in resources (i.e. productivity), the majority of respondents indicated a positive response, as shown in Figure 5.47.

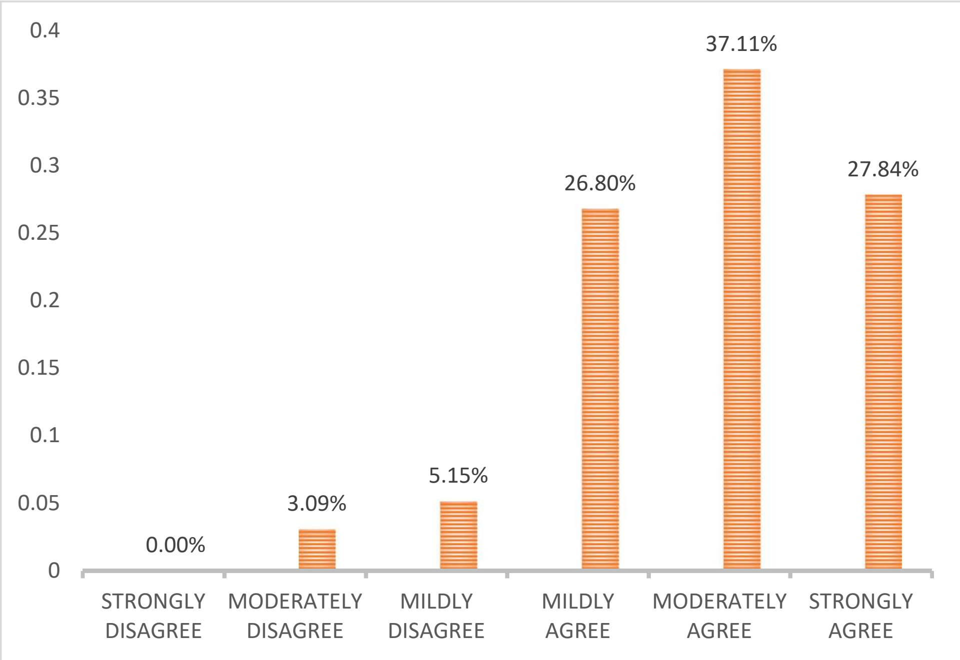


Figure 5.47: Productivity improvement (N=97)
Source: Author

5.10.6 Number of service defects, errors or breakdowns

This indicator was ranked 2nd by respondents with the majority indicating that service defects, errors and breakdowns have decreased, as shown in Figure 5.48. This is good news when measuring the impact of LSS on operations.

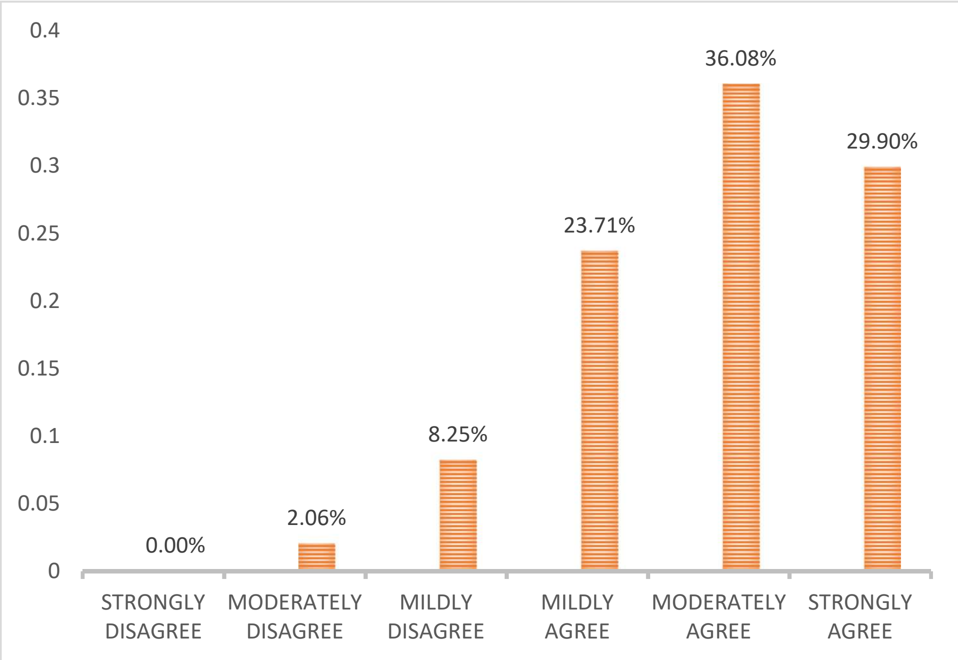


Figure 5.48: Number of service defects, errors or breakdowns (N=97)
Source: Author

5.10.7 The competitive position of the hospital

When quality improves, service errors reduce, the lead time for services decrease (e.g. Waiting times), it is expected that patient and customer satisfaction increase, and as a result, the hospital image and reputation in the market improves. When asked if LSS implementation had an impact on the competitive position of the hospital, the majority of the respondents agreed, as shown in Figure 5.49.

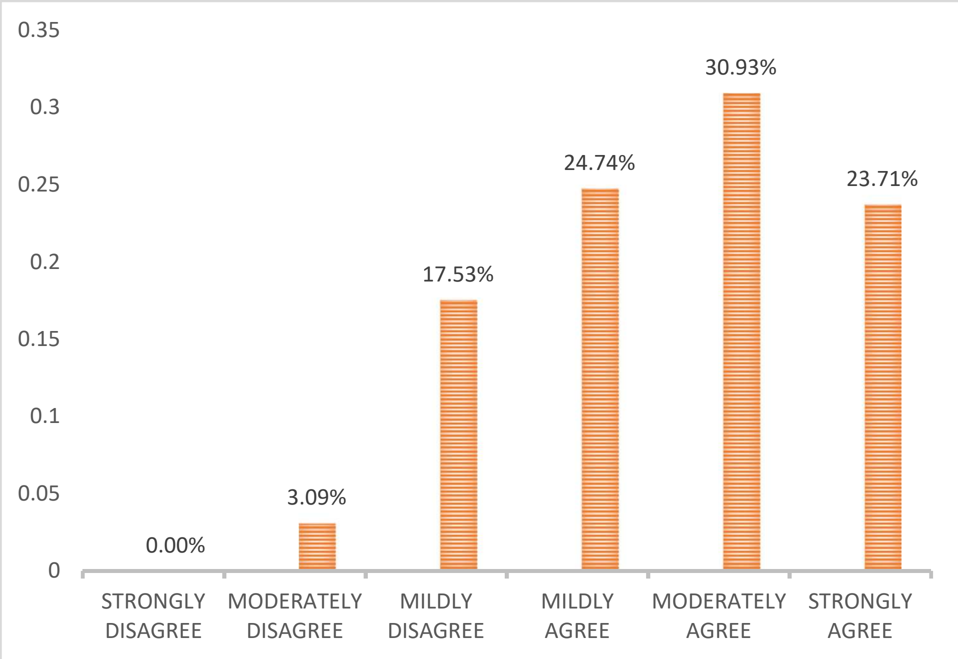


Figure 5.49: Competitive hospital position (N=97)
Source: Author

5.10.8 Waste in operations and processes

This was the number one reported indicator by respondents, as shown in Figure 5.50. The waste concept can be easily seen in many hospitals. For example, new medication orders written during rounds arrived late, patient waiting in ER, nurses looking for supplies or conducting unneeded or excessive tests (DelliFraine et al. 2010; Stanton et al. 2014). When LSS in implemented in healthcare, the waste would be identified and then reduced or removed. This is easily observed, and hence, it is one of the immediate and visible positive signs of LSS success.

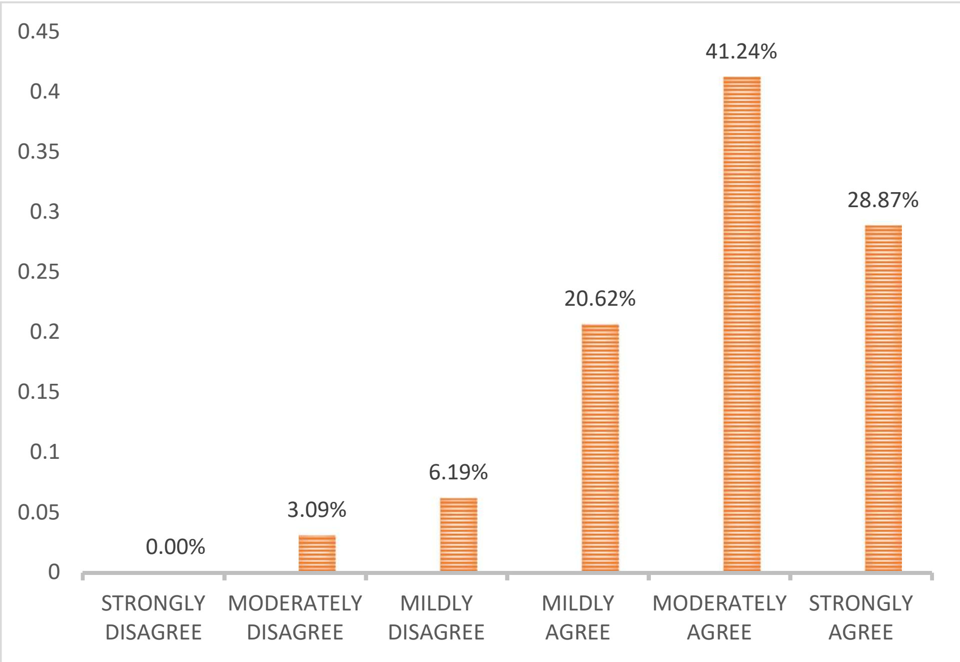


Figure 5.50: Waste in operations reduced (N=97)
Source: Author

5.11 Perception of LSS impact

This question was answered by respondents at hospitals where they are implementing or have implemented LSS. A high percentage of respondents indicated that the results of LSS implementation were either extremely successful (19.59%) or successful (53.61%), as shown in Figure 5.51. None of the respondents reported that LSS had a negative impact confirming earlier previous positive responses on LSS impact on hospital performance indicators.

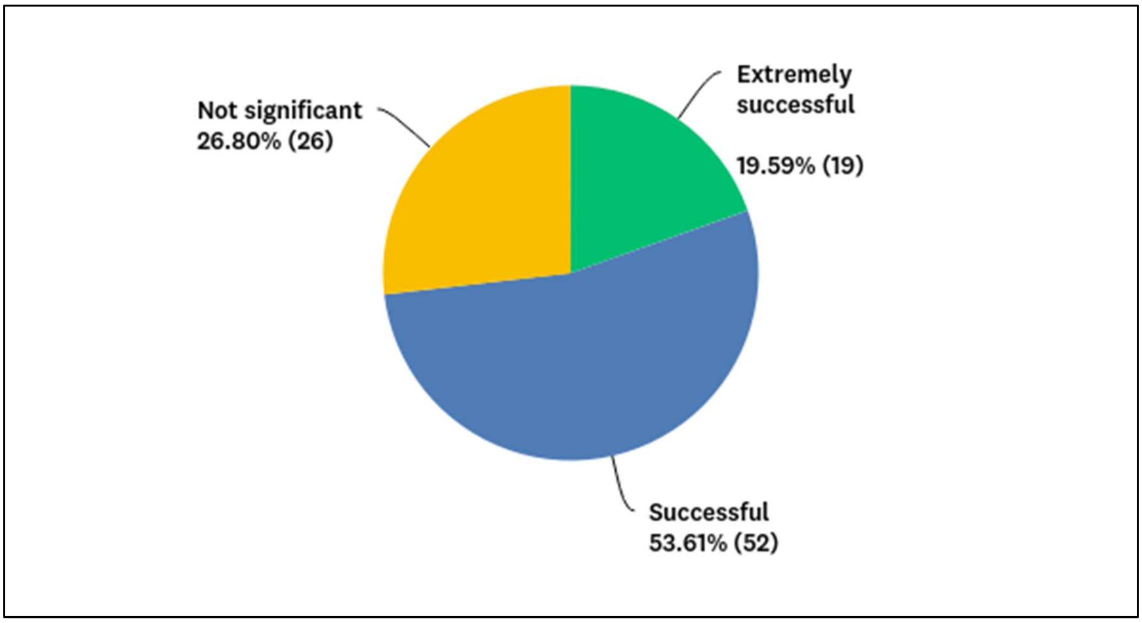


Figure 5.51: Perception of LSS impact in UAE hospitals (N=97)
Source: Author

5.12 CSF ranking

Figure 5.52 illustrates that the top 5 CSFs revealed in the survey were top management commitment, availability of resources, training and education, management of cultural change, project prioritisation, selection and tracking skills.When this study results were compared to the top global CSFs reported in the literature (Antony and Gupta 2018; Albliwi et al. 2014; Antony et al. 2018; Patil et al. 2017), it was noted that top management commitment and leadership ranks as the number one CSF for LSS successful deployment in all these studies.

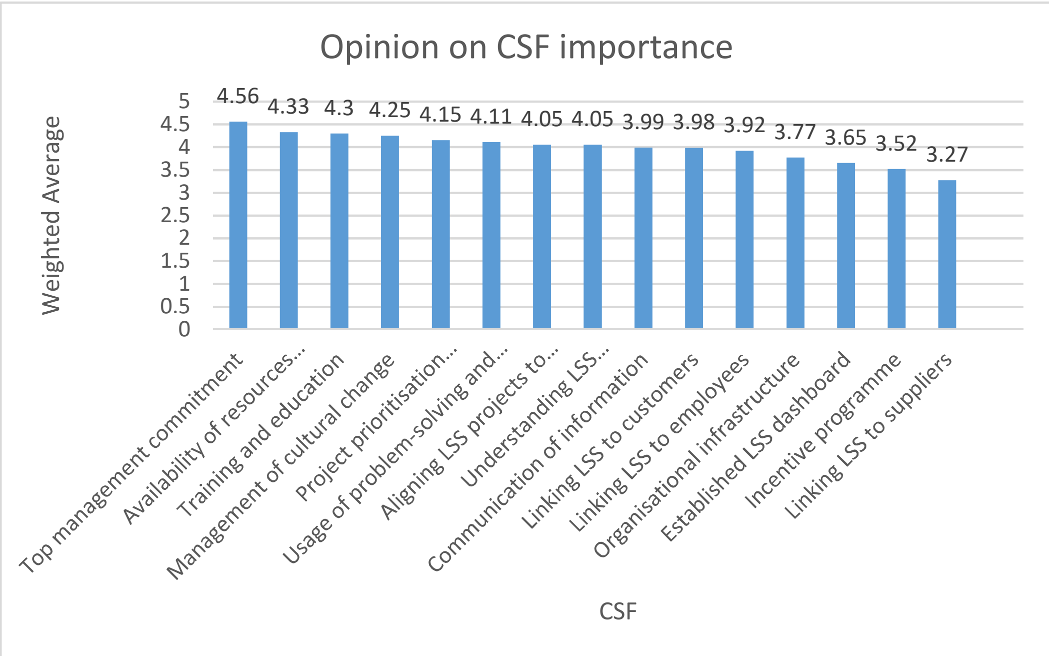


Figure 5.52: Ranking of CSFs for UAE healthcare (N=103)
Source: Author

Furthermore, the findings of this study CSFs ranking mirrored those of previous literature findings observed in Sreedharan et al. (2018) review of 41 peer-reviewed papers focusing on CSFs of various CI initiatives such TQM, Lean, Six Sigma and LSS across different sectors (Shown in Table 5.27). It is illustrated that the most important success factor was the top management commitment shadowed by training, communication, employee involvement, customer focus, culture (Management of culture change), teamwork, supplier focus and organizational infrastructure.

Table 5.27: Common factors of LSS

S. No.	Critical success factors	TQM	Lean	Six Sigma	Lean Six Sigma
1	Top management commitment	✓	✓	✓	✓
2	Training and education	✓	✓	✓	✓
3	Communication	✓	✓	✓	✓
4	Customer focus	✓	✓	✓	✓
5	Organizational culture	✓	✓	✓	✓
6	Employee involvement	✓	✓	✓	✓
7	Teamwork	✓	✓	✓	✓
8	Supplier focus	✓		✓	✓
9	Understanding tools and techniques		✓	✓	✓
10	Organizational infrastructure			✓	✓

Source: (Sreedharan et al. 2018, p.3496)

The top 5 identified CSFs, shown in Figure 5.52, further supported the findings of Albliwi et al. (2017) for Saudi Arabia organisations where the researchers reported the following top 5 CSFs : training and education , top management commitment and support, availability of resources, project selection and prioritisation and communication. Although the ranking of these CSFs may differ slightly from the CSFs in this study due to various reasons, many CSFs were common. This was no surprise as the UAE and Saudi Arabia share similar cultural and demographical traits.

Similarly, this study findings further supported Antony et al. (2018) results revealed in their recent systematic review of 68 papers related to Six Sigma in healthcare across the six continents. However, the researchers' findings showed some differences in the ranking of CSFs from one continent to another, probably due to different maturity levels of Six Sigma in their countries. For example, the top CSF in North America, Europe and Australia was management involvement and commitment followed by organisation culture, cultural change, communication, training, customer focus, and understanding Six Sigma tools. Interestingly, Asia respondents did not report management involvement and commitment within the top five success factors and reported understanding of Six Sigma tools as the number one factor.

5.13 Future of Lean Six Sigma

Respondents indicated a positive outlook when asked about their perception on the future of LSS where 82% indicated that LSS is growing in importance, as shown in Figure 5.53. This presents an excellent opportunity for LSS healthcare practitioners to hone on the skills needed to deploy LSS and employ suitable frameworks to ensure the sustainability of these initiatives. Moreover, it presents research opportunities for academics to pursue validating deployment models to improve the success of LSS projects.

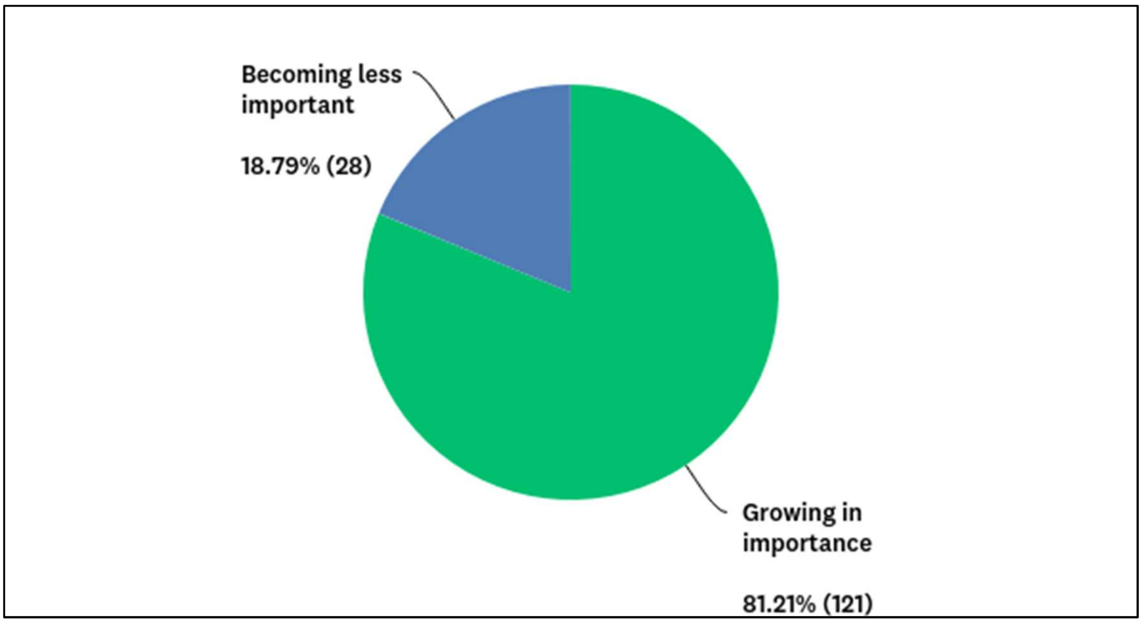


Figure 5.53: Future of LSS in UAE hospitals (N=149)
Source: Author

5.14 Summary

There are a number of findings in this chapter: first, results showed that most of the implementation of LSS occur at hospitals located in the two largest UAE Emirates, namely Abu Dhabi and Dubai. This could be due to the fact that the two Emirates host most of the UAE population and further tends to get most of the support from the government and private investors.

Second, the following 5 CSFs were reported by the respondents for UAE hospitals: top management commitment availability of resources, training and education, management of cultural change, project prioritisation, selection and tracking, usage of problem solving and statistical thinking tools and understanding LSS methodology. These results mirrored numerous global studies results (Sreedharan et al. 2018; Hilton et al. 2008; Albliwi et al.

2014; Al-Balushi et al. 2014). Additionally, there was an agreement with the top CSFs in neighbouring Saudi Arabia, according to Albliwi et al. (2017). This study findings slightly differed from the results of a recent review of LSS in global healthcare by Antony et al. (2018) which identified the following top CSFs: understanding of Six Sigma tools and techniques, management involvement and commitment, communication, organization infrastructure and culture, training, patient focus and cultural change. However, the ranking of these CSFs varied when compared across the six continents reviewed in the same paper. It could be argued that the geography (i.e. culture, the maturity of quality systems, job dynamics, etc.) of a study have some impact on CSFs ranking.

Third, the UAE healthcare challenges were similar when compared to other sectors and geographies when it comes to deploying LSS. Results showed that the major challenges for LSS in UAE hospitals were predominantly centred on lack of resources, internal resistance, change of management, inadequate training/coaching and competing projects. These challenges aligned with the literature (Albliwi et al. 2017) that identified the following LSS implementation challenges: time-consuming, lack of resources, unmanaged expectations, lack of awareness about LSS benefits and lack of training or coaching. Moreover, this study findings agreed with Antony et al. (2018) where they identified the following top challenges: availability of data, cultural issues, resistance to change, the sustainability of results, insufficient resources, inadequate knowledge of Six Sigma, the complexity of current practice and lack of leadership commitment.

Fourth, respondents indicated that the most impacted hospital performance indicators as a result of LSS were: waste reduction in operations, reduction in service defects and errors and increase in productivity. These results agreed with previous literature on hospital measures discussed earlier in section 2.9.1. This was no surprise as UAE hospitals follow international guidelines and regulations when it comes to performance indicators.

Fifth, respondents reported that 22.34% of the LSS projects were at the hospital's operations areas (e.g. administration) followed by clinical areas (20.98%) and customer service areas (16.62%). This was an encouraging result as hospitals seem to implement LSS in areas linked to business objectives and customers, both being CSFs for LSS. These findings are aligned with the findings from Albliwi et al. (2017) where the researchers reported that LSS in Saudi Arabia was implemented in customer service, administrative processes and production processes noting that their study was conducted in different sectors and was not limited to healthcare.

The next chapter will present quantitative and qualitative analysis. The PLS-SEM analysis and the testing of the measurement and structural models are presented to draw conclusions on the validity of the proposed hypotheses. Also, the analysis of the interviews is presented.

CHAPTER 6: QUANTITATIVE AND QUALITATIVE ANALYSIS

6.1 Quantitative analysis : PLS-SEM

The next sections outline the methods and present the results of the PLS-SEM analysis. A PLS-SEM model is composed of two parts, namely the outer (measurement) model consisting of the relationships between the indicators and the latent variables, analyzed by composite factor analysis, and the inner (structural) model consisting of the relationships between the endogenous and exogenous latent variables, analyzed by path analysis (Hair et al 2017). The generalized structure of each path diagram is outlined in Figure 6.1, where the rectangular symbols represent the indicators (i.e., the questionnaire item scores measured with Likert scales); the oval symbols represent the latent variables (i.e., the constructs quantified as an exact linear combination of the indicators computed by composite factor analysis); λ = the standardised loading coefficients computed by composite factor analysis, ranging from 0 to 1; and β = standardized path coefficient representing a standardized partial regression coefficient or β weights, ranging from -1 through 0 to + 1. Because the questionnaire item scores reflected multiple interchangeable facets of each construct, using indicators that were conceptually and statistically related to each other, and subject to measurement error (because they represented the perceptions of the respondents), all of the latent variables were defined as reflective (Hair et al. 2017; Howell et al. 2007). Therefore the reliability and validity of each reflective variable had to be evaluated.

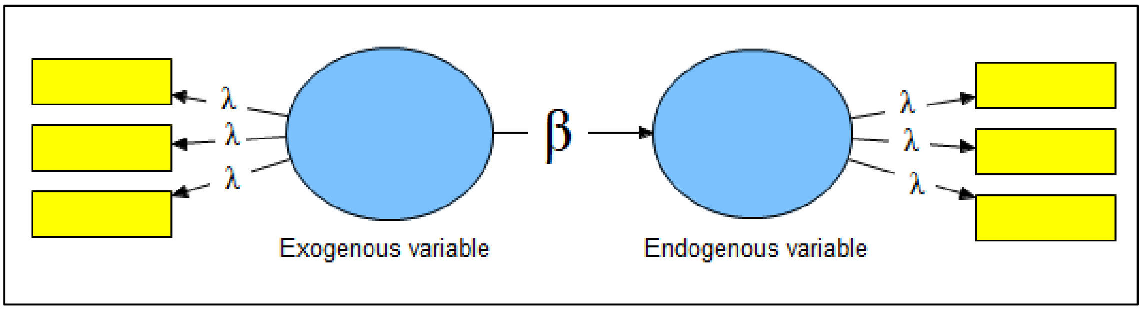


Figure 6.1: Generalized structure of a path diagram
Source: Author (adapted from (Hair et al. 2017))

6.2 Sample size

Although there was a total of 101 respondents, 4 of the respondents' questionnaires were excluded as the respondents did not answer the questions on hospital performance. Therefore, the total sample size used in PLS-SEM was 97. The results of a power analysis, using the method described by Hair et al. (2017) indicated that to achieve adequate power (0.8) assuming a conventional level of statistical significance (0.05) and weak effect size ($R^2 = 0.25$) the minimum required sample size should be 80. Therefore, the sample size of 97 exceeded the minimum requirement, and so the analysis was not underpowered.

6.3 Content validity

As advanced earlier in chapter 2, a thorough literature review was conducted to establish the content validity of proposed constructs; hence the literature review served as a source of identification of the proposed models, and the content domains of each construct and a number of models were proposed. Thus, the content validity for the four constructs was established based on theoretical considerations.

6.4 Data distribution

PLS-SEM is a non-parametric method, and therefore the empirical data collected to operationalize the latent variables or constructs does not necessarily have to be normally distributed; however, excessive non-normality may inflate the standard errors when using the results of bootstrapping to test for the statistical significance of the path coefficients. Therefore tests for normality were conducted. Table 6.1 shows that all of the indicators measured in the survey, based on a sample size of $N = 97$, deviated significantly and very strongly from normality, indicated by $p < .001$ for the Kolmogorov-Smirnov and Shapiro-Wilk tests (Saunders et al. 2009). The reason for the deviations from normality was that the majority of the respondents tended to agree to the items; therefore most of the scores ranged from 4 and 6 (as exemplified by the frequency distribution histograms for the indicators selected to operationalize Hospital Performance indicators in Figure 6.2). Although PLS-SEM does not require the distributions to be normal, this may still affect the conclusions and need to be taken into consideration in further analysis.

Table 6.1: Tests for normality of indicators

Indicator	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	p	Statistic	df	p
STMC	.267	97	<.001	.789	97	<.001
SMCC	.247	97	<.001	.865	97	<.001
SAOR	.224	97	<.001	.903	97	<.001
OLLC	.257	97	<.001	.737	97	<.001
SOIN	.191	97	<.001	.882	97	<.001
SABO	.267	97	<.001	.759	97	<.001
OLLS	.164	97	<.001	.931	97	<.001
TTED	.242	97	<.001	.840	97	<.001
TUPS	.241	97	<.001	.842	97	<.001
TLLE	.222	97	<.001	.902	97	<.001
SULM	.178	97	<.001	.870	97	<.001
TIPR	.148	97	<.001	.930	97	<.001
SCOI	.172	97	<.001	.927	97	<.001
OESD	.152	97	<.001	.924	97	<.001
OPPS	.234	97	<.001	.852	97	<.001
HPAS	.234	97	<.001	.859	97	<.001
HSLT	.219	97	<.001	.873	97	<.001
HEMS	.212	97	<.001	.908	97	<.001
HEMT	.172	97	<.001	.930	97	<.001
HPRI	.223	97	<.001	.865	97	<.001
HNSD	.224	97	<.001	.869	97	<.001
HWAR	.203	97	<.001	.893	97	<.001
HICP	.254	97	<.001	.853	97	<.001

df: degrees of freedom- Source: Author

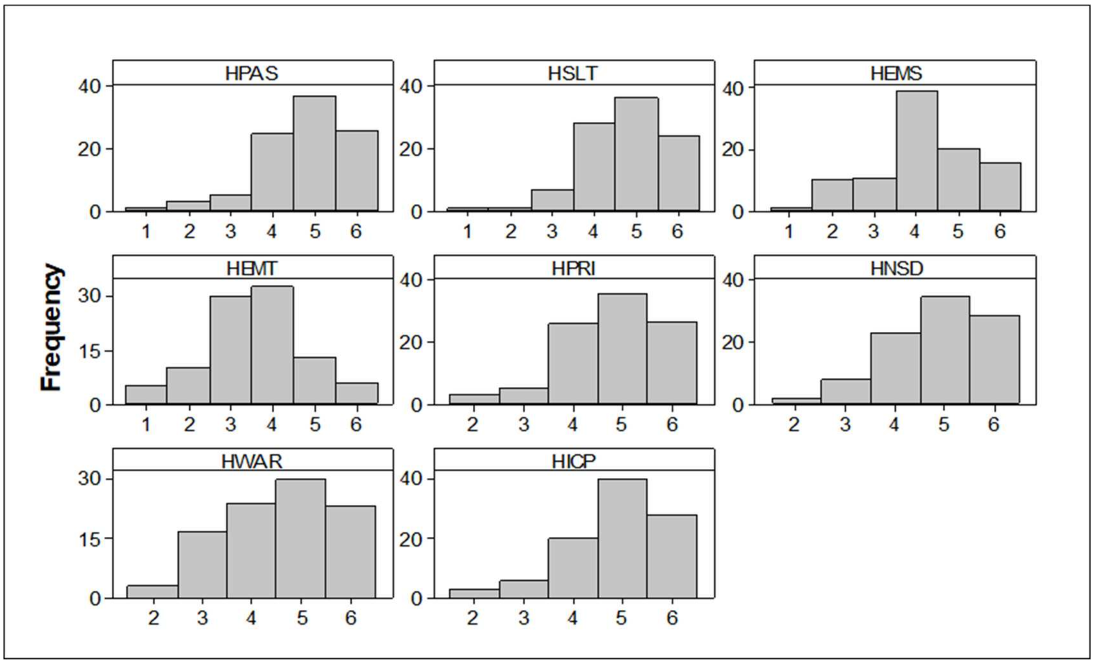


Figure 6.2: Examples of skewed frequency distributions of indicators
Source: Author

6.5 Evaluation of the measurement models

In PLS-SEM analysis, it is critical that the measurement model or the outer model is tested to meet certain requirements with regards to reliability and validity. The following sections will present more details on the evaluation of both model types.

6.6 Reliability of the measurement models

In PLS-SEM the evaluation of the reliability of the measurement model for reflective measures is evaluated on the basis of the collective reliability measure, composite reliability, as well as on the basis of each of the variables' individual reliability (Hair et al. 2017).

6.6.1 Composite reliability

Composite reliability is a measure of the internal consistency which is suitable for PLS-SEM studies. According to Hair et al. (2017), composite reliability values below 0.60 indicate a lack of reliability while other researchers such as Nunnally and Bernstein (1994) argued that composite reliability values of 0.60 to 0.70 are regarded as acceptable in explorative research. In this study, a composite reliability coefficient greater than 0.70 was assumed to indicate internal consistency reliability, meaning that the items used to measure the latent variable were uniformly related to each other.

6.6.2 Loading reliability

It is essential to assess the reliability of each of the variable within the model by means of the individual correlations between the variables and their theoretically associated latent variable. The literature calls for an adequate correlation between the variables and the respective latent construct to ensure that the latent construct is reflected in the selected variables. The reliability of the individual variables is evaluated on the basis of how much each of the variables loads on the latent constructs (Hair et al. 2017; Hair et al. 2012).

Hair et al. (2017) suggested removing variables with loadings between 0.40 and 0.70 if the removal leads to increased composite reliability and no loss of validity. Nevertheless, according to Hair et al. (2017), variables with loadings below 0.40 should be eliminated from reflective scales as the correlations might be subscribed to coincidences instead of true identifiable relations.

6.7 Validity of the measurement models

To assess the validity of the measurement models for reflective models, an examination needs to be conducted via the measures of convergent validity and discriminant validity (Hair et al. 2017).

6.7.1 Construct validity

Construct validity measures if construct indicators accurately measure what they intend to from the perspective of relationships between constructs and their relative indicators. One may describe construct validity as the set of indicators as a whole that covers the construct concept. Construct validity is assessed through convergent validity and discriminant validity.

6.7.2 Convergent validity

Convergent validity, indicated by the Average Variance Extracted (AVE), examines if the indicators of latent variables are highly correlated with these variables or measures the extent to which the indicators explained the variance in each latent variable. The AVE must be higher than 50%, which is the critical threshold to ensure that the indicators explained most of the variance in the latent variable (Hair et al. 2017). If the AVE is less than 50%, then most of the variance was due to random measurement error, and the latent variable is not a valid representation of a meaningful construct. Convergent validity is also indicated by the factor loading coefficients (i.e., the correlations between each indicator and the latent variable). Indicators with loadings less than about 0.50 could be eliminated because the correlations might be subscribed to coincidences instead of a systematic relationship (Hair et al. 2017).

6.7.3 Discriminant validity

Discriminant validity means that the latent variables were conceptually distinct and that the indicators differentiated between individual latent variables. In this study, the discriminant validity was assessed using the Fornell-Larcker's criterium and cross-loading for variables, as explained earlier in the methodology chapter.

In summary, the quality criteria used to validate the measurement model were: sample size, data distribution, composite reliability, convergent validity, and discriminant validity, using the methods described by Hair et al. (2017) and Fornell and Larcker (1981). If a model could be validated using the defined quality criteria, then the second phase of the analysis is justified, including the evaluation of the structural model, based on the analysis of the path coefficients and R^2 values, and the testing of the associated hypotheses. However, if the defined quality criteria are not satisfied, and the measurement model could not be validated then it is not justifiable to interpret the path coefficients or R^2 values of an invalid model or to test any hypotheses associated with that model.

Following a discussion of the methods to test the reliability and validity of the models, the results of PLS-SEM are presented in two stages. The first stage involved the validation of the measurement model, and the second stage involved the evaluation of the structural model. SPSS 20 and SmartPLS 3.0 were used for data analysis.

6.8 Composite reliability results

Table 6.2 shows that all of the latent variables used in Models A, B and C had good internal consistency reliability, reflected by Composite Reliability Coefficients greater than 0.8 (ranging from 0.831 to 0.926).

6.8.1 Average Variance Extracted (AVE) results

Table 6.2 shows that most of the latent variables used in Models B and C had good lower than the critical threshold value, indicating that this latent variable may have inadequate convergent validity. The next section will discuss the procedure to address the low AVE convergent validity, reflected by AVE greater than the critical threshold value of 50%. However, the AVE values for the STO CSFs in Model A, B, and C (shown in **bold**) were.

Table 6.2: Composite Reliability/ AVE Latent Variables in Models A, B, C before exclusion

Model	Latent variable	Composite Reliability	AVE (%)
A	STO CSFs	0.926	**38.8%**
	Hospital Performance	0.890	61.2%
B	Strategic CSFs	0.739	**37.2%**
	Tactical CSFs	0.851	58.9%
	Operational CSFs	0.830	55.9%
	Hospital Performance	0.926	61.2%
C	Strategic CSFs	0.734	**36.5%**
	Tactical CSFs	0.852	59.0%
	Operational CSFs	0.830	56.1%
	Hospital Performance	0.926	61.0%

Source: Author

6.8.2 Factor Loadings and Discriminant Validity

Table 6.3 presents the composite factor loadings for the indicators selected to operationalize the two latent variables in Model A, as well as the cross-loadings of the indicators for each variable. The loadings for the indicators selected by the author to operationalize each latent variable were greater than the cross-loadings for the same indicators on the other latent variable; therefore, the two latent variables were conceptually distinct. Moreover, Fornell-Larcker values are presented in Table 6.4. As a result, discriminant validity is confirmed.

The loadings for each of the 8 indicators selected to operationalize Hospital Performance in Model A were all greater than the threshold value of 0.5. These results satisfied the quality criteria to confirm the convergent validity of Hospital Performance as a latent variable in Model A. In contrast, the loadings for 3 of the 15 indicators selected to operationalize STO CSFs (OPPS, SCOI, and SOIN) were less than the critical threshold value of 0.5 (0.448, 0.077, and -0.049 respectively). Exclusion of OPPS, SCOI, and SOIN factors from Model A improved the AVE to 47.0%.

Table 6.3: Factor loadings for Model A

Indicators	Hospital Performance	STO CSFs
HEMS	**0.827**	0.555
HEMT	**0.733**	0.549
HICP	**0.796**	0.531
HNSD	**0.835**	0.387
HPAS	**0.749**	0.511
HPRI	**0.854**	0.535
HSLT	**0.694**	0.398
HWAR	**0.757**	0.353
OESD	0.453	**0.800**
OLLC	0.496	**0.691**
OLLS	0.349	**0.733**
OPPS	0.270	**0.448**
SABO	0.346	**0.558**
SAOR	0.413	**0.719**
SCOI	0.006	**0.077**
SMCC	0.440	**0.736**
SOIN	-0.088	**-0.049**
STMC	0.447	**0.616**
SULM	0.405	**0.617**
TIPR	0.375	**0.614**
TLLE	0.370	**0.616**
TTED	0.468	**0.692**
TUPS	0.500	**0.766**

Note: Indicators highlighted in **bold** were selected to operationalize the latent variables
Source: Author

Table 6.4: Fornell-Larcker for Model A

	Hospital performance	STO CSFs
Hospital performance	**0.782**	
STO CSFs	0.626	**0.623**

Source: Author

Moreover, the exclusion of three variables is presumed that it will not severely damage the content validity. According to Hulland (1999), AVE values above 40% or 50% can be considered appropriate. Hence, the author, given that the Composite Reliability is above 60% for STO CSFs and the closeness of the updated AVE to 50%, decided to accept Model A for further evaluation (Fornell and Larcker 1981). In Models B and C, only the variables SCOI and SOIN were deemed for exclusion as the STO CSFs AVE values increased to 51.8% and 50.1% respectively while keeping the OPPS variable as its loading was very close to 0.5.

Similarly, Tables 6.5, 6.6, 6.7, 6.8, 6.9 and 6.10 present the factor loadings and Fornell-Larcker values for the indicators selected to operationalize the latent variables in Models A, B and C respectively. The loadings for each of the indicators selected to operationalize the latent variables were all greater than the critical threshold value of 0.5. The loadings for the indicators selected by the author to operationalize each latent variable were greater than the cross-loadings for the same indicators on the other latent variables; therefore the latent variables were conceptually distinct, and discriminant validity was confirmed. These results satisfied the quality criteria to interpret and justify the testing of hypotheses for Models A, B and C.

Table 6.5: Factor loading for Model A after exclusion of OPPS, SCOI, SOIN

Indicators	Hospital Performance	STO CSFs
HEMS	**0.827**	0.554
HEMT	**0.733**	0.546
HICP	**0.796**	0.528
HNSD	**0.836**	0.389
HPAS	**0.748**	0.507
HPRI	**0.854**	0.532
HSLT	**0.692**	0.389
HWAR	**0.759**	0.362
OESD	0.453	**0.809**
OLLC	0.496	**0.69**
OLLS	0.349	**0.745**
SABO	0.346	**0.548**
SAOR	0.413	**0.717**
SMCC	0.44	**0.738**
STMC	0.447	**0.61**
SULM	0.404	**0.622**
TIPR	0.375	**0.618**
TLLE	0.369	**0.625**
TTED	0.468	**0.701**
TUPS	0.499	**0.76**

Note: Indicators highlighted in **bold** were selected to operationalize the latent variables
Source: Author

Table 6.6: Fornell-Larcker for Model A after removal of OPPS, SCOI, SOIN

	Hospital performance	STO CSFs
Hospital performance	**0.782**	
STO CSFs	0.623	**0.686**

Source: Author

Table 6.7: Factor loadings for Model B

Indicator	Hospital Performance	Operational	Strategic	Tactical
HEMS	**0.826**	0.430	0.525	0.517
HEMT	**0.732**	0.488	0.533	0.448
HICP	**0.797**	0.448	0.466	0.522
HNSD	**0.836**	0.296	0.354	0.389
HPAS	**0.749**	0.523	0.475	0.391
HPRI	**0.854**	0.462	0.454	0.528
HSLT	**0.695**	0.366	0.361	0.356
HWAR	**0.757**	0.284	0.372	0.292
OESD	0.453	**0.838**	0.668	0.676
OLLC	0.497	**0.816**	0.597	0.483
OLLS	0.349	**0.786**	0.596	0.621
OPPS	0.270	**0.499**	0.407	0.319
SABO	0.346	0.435	**0.684**	0.365
SAOR	0.412	0.628	**0.814**	0.482
SMCC	0.440	0.574	**0.850**	0.534
STMC	0.447	0.633	**0.663**	0.365
SULM	0.404	0.445	**0.548**	0.661
TIPR	0.374	0.495	0.458	**0.701**
TLLE	0.369	0.508	0.423	**0.743**
TTED	0.468	0.579	0.532	**0.775**
TUPS	0.500	0.591	0.634	**0.844**

Note: Indicators highlighted in **bold** were selected to operationalize the latent variables
Source: Author

Table 6.8: Fornell-Larcker for Model B

	Hospital performance	Operational	Strategic	Tactical
Hospital performance	**0.782**			
Operational	0.542	**0.747**		
Strategic	0.578	0.768	**0.720**	
Tactical	0.564	0.711	0.676	**0.768**

Source: Author

Table 6.9: Factor loadings for Model C

	Hospital Performance	Operational CSFs	Strategic CSFs	Tactical CSFs
HEMS	**0.827**	0.436	0.541	0.518
HEMT	**0.740**	0.496	0.536	0.450
HICP	**0.787**	0.434	0.470	0.519
HNSD	**0.822**	0.280	0.348	0.388
HPAS	**0.765**	0.505	0.454	0.389
HPRI	**0.845**	0.445	0.458	0.525
HSLT	**0.702**	0.352	0.350	0.354
HWAR	**0.750**	0.280	0.368	0.290
OESD	0.456	**0.862**	0.670	0.676
OLLC	0.504	**0.774**	0.559	0.482
OLLS	0.357	**0.825**	0.612	0.622
OPPS	0.276	**0.470**	0.388	0.316
SABO	0.345	0.421	**0.658**	0.359
SAOR	0.417	0.633	**0.810**	0.484
SMCC	0.443	0.576	**0.837**	0.534
STMC	0.456	0.616	**0.580**	0.361
SULM	0.405	0.466	**0.645**	0.660
TIPR	0.374	0.508	0.490	**0.711**
TLLE	0.371	0.526	0.463	**0.752**
TTED	0.469	0.588	0.552	**0.765**
TUPS	0.500	0.592	0.656	**0.840**

Note: Indicators highlighted in **bold** were selected to operationalize the latent variables
Source: Author

Table 6.10: Fornell-Larcker for Model C

	Hospital performance_	Operational	Strategic	Tactical
Hospital performance	**0.781**			
Operational	0.539	**0.749**		
Strategic	0.581	0.757	**0.713**	
Tactical	0.563	0.722	0.710	**0.768**

Source: Author

6.9 Evaluation of the structural models

After validating the measurement models, the structural models A, B and C were evaluated. The aim of the evaluation was to predict the relationships between the latent variables.

6.9.1 The coefficient of determination (R^2)

The R^2 value can show the influence value of the exogenous variable to the endogenous variable. In PLS, R^2 represents the amount of variance in a specific endogenous latent construct that is explained by the exogenous latent variables pointing at this construct (Chin 2010). The R^2 value of 0.75 shows a strong model; 0.50 indicates a moderate model, while 0.25 indicates a weak model (Hair et al. 2017). While Cohen (1988) suggested that the values of R^2 above are 0.26 considered substantial, values above 0.13 are moderate, whereas values between 0 to 0.02 are weak.

In this study, bootstrapping with 5000 random subsamples was conducted to estimate the mean and standard error (SE) of each path coefficient (β). If the t-test statistic (where $t = \beta/SE$) was ≥ 1.96, then the β coefficient was significantly different from zero at the 0.05 level of statistical significance (Hair et al. 2017).

Table 6.11 shows the computed R^2 values for the endogenous variables. The R^2 values indicated a less than moderate (< 0.5) effect size for the prediction of Hospital Performance in Models A, B, and C (R^2 = 0.388, 0.394, and 0.291 respectively). In Model C, the effect sizes were also more than moderate to predict Operational effects (0.521) and Tactical CSFs (0.504).

Table 6.11: R^2 values for Models A, B and C

Model	R^2		
	Hospital performance	Operational CSFs	Tactical CSFs
A	0.388		
B	0.394		
C	0.291	0.521	0.504

Source: Author

6.9.2 Path coefficients

Table 6.12 presents the results of the t-tests to determine if the mean values of the path coefficients were different from zero at the 0.05 level (indicated by t > 1.96).

Table 6.12: Analysis of path coefficients (β) for Models A, B and C

Model	Hypothesis	Path	Sample β (N = 97)	Bootstrap Mean β (N = 5000)	SE	t	Hypothesis Decision
A	**HP**	**STO CSFs → Hospital performance**	**0.623**	**0.642**	**0.065**	**9.539**	**Path supported**
B	**H1**	**Strategic CSFs → Hospital performance**	**0.306**	**0.321**	**0.151**	**2.021***	**Path supported**
B	**H2**	**Tactical CSFs → Hospital performance**	**0.282**	**0.275**	**0.129**	**2.183***	**Path supported**
B	**H3**	**Operational CSFs → Hospital performance**	**0.106**	**0.113**	**0.128**	**0.828**	**Path not supported**
C	**H4**	**Strategic CSFs → Tactical CSFs**	**0.710**	**0.725**	**0.046**	**15.597***	**Path supported**
C	**H5**	**Tactical CSFs → Operational CSFs**	**0.722**	**0.730**	**0.065**	**11.105***	**Path supported**
C	**H6**	**Operational CSFs → Hospital performance**	**0.539**	**0.557**	**0.071**	**7.646***	**Path supported**

Note: * p < .0.05 for the t-test statistic
Source: Author

A t-test statistic greater than 1.96 provided limited evidence to support the research hypotheses (H1 to H6) in combination with the R^2 values, which measured the effect sizes (Hair et al. 2017). No null hypotheses were accepted or rejected by interpreting the p-values, following the formal statement issued by the American Statistical Association asserting that it is impossible to prove that a null hypothesis is true or false through the interpretation of dichotomized p-values as the magnitude of p-value does not measure the size of an effect or the importance of a result, and that by itself, a p-value does not provide a good measure of evidence regarding the validity of a model (Wasserstein and Lazar 2016; McShane and Gal 2017).

For Model A, the hypothesis that STO CSFs predicted Hospital performance was supported. For Model B, the hypotheses that Strategic CSFs and Tactical CSFs predicted Hospital performance was supported, whereas the hypothesis that Operational CSFs predicted Hospital performance was not supported. In Model C, where the relationships between the CSFs were assumed to be sequential, the hypotheses (i.e. Strategic CSFs predicted Tactical CSFs, Tactical CSFs predicted Operational CSFs, and Operational CSFs predicted Hospital performance) were supported. Models A and C were superior to Model B because all their associated hypotheses were supported.

6.10 Moderation analysis

Moderation analysis was conducted using the generalized moderator model outlined in Figure 6.3 (Jose 2013). The moderating effect, reflecting the effect of a moderator on the strength and direction of the correlation between a predictor and an outcome is indicated by the path coefficient between the interaction term (predictor x moderator) and the outcome. In this study, the predictor is STO CSFs, while the outcome is Hospital performance. The four potential moderators evaluated using the 'Create moderating effect' procedure in SmartPLS were Hospital JCI accreditation status (1 = Yes or 0 = No), Hospital size, measured by the number of beds, Hospital type: 1 = Governmental or 0 = Private, and ISO 9001 certification status (1 = Yes or 0 = No). The moderating effect is assumed to be significant at the 0.05 level if the t-test statistic is > 1.96. The other two paths in the model (between the predictor vs the outcome, and the moderator vs the outcome) were assumed to be conceptually and statistically irrelevant (Jose 2013). The results of the moderation analysis are presented in Table 6.13.

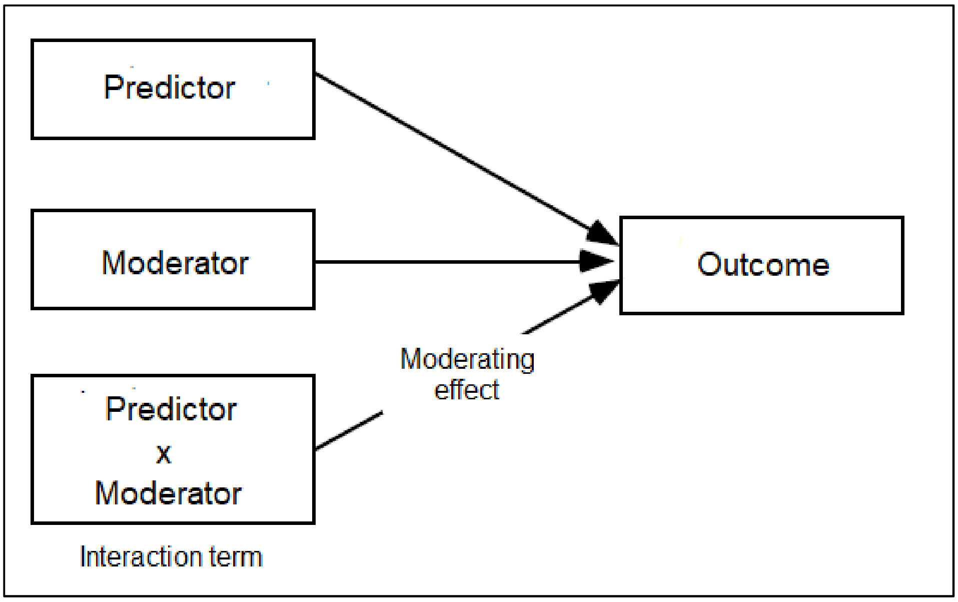


Figure 6.3: Generalized moderator model
Source: Author: Adapted from (Jose 2013).

Table 6.13: Moderation analysis

Predictor	Moderator	Outcome	Sample β (N = 97)	Bootstrap Mean β (N = 5000)	SE	t	Decision
STO CSFs	**JCI accreditation status**	**Hospital performance**	**-0.010**	**-0.011**	**0.177**	**0.055**	**Not Significant**
STO CSFs	**Hospital size**	**Hospital performance**	**0.206**	**0.182**	**0.146**	**1.413**	**Not Significant**
STO CSFs	**Hospital type**	**Hospital performance**	**0.132**	**0.113**	**0.115**	**1.151**	**Not Significant**
STO CSFs	**ISO certification status**	**Hospital performance**	**-0.031**	**-0.033**	**0.101**	**0.301**	**Not Significant**

Source: Author

Table 6.13 clearly illustrates that all of the t-test statistics were < 1.96, implying that JCI accreditation status, Hospital size, Hospital type, and Hospital size were not significant moderators of the relationship between LSS STO CSFs and Hospital performance at the 0.05 level.

The Smartpls analysis graphs for Models A, B, C and the moderators' analysis are included in Appendix N.

6.11 Summary of quantitative results

The above sections examined the proposed models and their associated hypotheses. There are a number of key findings. In Model A, the hypothesis for LSS STO CSFs impact organizational performance (e.g. hospital performance) was supported, explaining 38.8% of the variance in hospital performance. The result supported that LSS has a positive impact on organizational performance which is widely reported in the literature (Alosani and Yusof 2018; Ali et al. 2016; Zagloel et al. 2018; Silva et al. 2018; Lamine and Lakhal 2018; Sabry 2014). Similar to other empirical studies in other countries, this study concluded that the UAE healthcare sector could benefit from LSS implementation.

Interestingly in this study, the factors ‘communication’, ‘organizational infrastructure’ (e.g. cross-functional teams) and ‘project selection, prioritization and tracking’ were not significant and hence were dropped from model A to increase its discriminant validity, while ‘project selection, prioritization and tracking’ variable was maintained for the other models. Model B explored if LSS CSFs individual STO themes contributed to hospital performance. Results showed that Strategic and Tactical CSFs impacted hospital performance, explaining 39.4% of the variance in hospital performance while the impact of the Operational CSFs was not supported. Model C three hypotheses were supported by statistically significant path coefficients ($p < 0.05$), including practically significant coefficients of determination R^2 reflecting more than moderate effect sizes (> 0.5) where 50.4% of the variation of Tactical element was explained, and 52.1% of the Operational element was explained while 29.1% of the hospital performance variation was explained in this model. This confirmed a sequential link with Strategic factors supporting Tactical factors that support operational CSFs leading to Hospital Performance.

A significant contribution from this study is that it confirmed the positive impact of LSS CSFs on hospitals performance while proposing a new sequential path model showing the relative interdependence and significant link between STO CSFs and hospital performance. Few researchers attempted to study sequential models. For example, the study of Lamine and Lakhal (2018) examined the sequential relationship between Six Sigma management practices (e.g. Top management commitment and support, infrastructure practices (e.g. Training and teamwork) and core practices (e.g. Six sigma structured approach) leading to organizational outcomes (e.g. organizational performance). However, their study was in a different context and geography. This becomes a vital finding where a sequential relationship between the CSFs was established.

Finally, there was no statistical evidence to indicate that JCI accreditation status, Hospital size (in terms of the number of hospital beds), Hospital type, and ISO 9001 certification status had a moderating effect on the relationship between STO CSFs and Hospital performance.

6.12 Qualitative Interviews analysis

In addition to complementing the quantitative findings, the interviews helped to explore the extent of LSS implementation, barriers to implementation, factors that supported the implementation, areas of implementation, the impact of LSS and hospitals measures.

The sample population for the interviews included 8 UAE healthcare quality and LSS professionals from 7 UAE hospitals. This sample size was considered adequate, as larger sample sizes or population is not required for exploratory qualitative research (Boddy 2016; Green and Thorogood 2009; Guest et al. 2006).

6.13 Interviews findings and discussion

The next sections present the results from the 8 interviews in order of importance, as mentioned by the interviewees. The interviewees' positions and hospitals details are shown in the Table in Appendix I where the code (I#) was given to each of the interviewees to reference the quotes below.

6.13.1 LSS implementation barriers

Various barriers to LSS implementation surfaced during the interviews. In the views of the interviewees, the barriers obstructed the launch, deployment or sustainability of LSS at their hospitals. These barriers are classified into two categories: common themes where several interviewees discussed the issue and individual themes where one interviewee strongly expressed his/her opinion on the respective barrier.

Common themes:

Lack of top management involvement and support

Several interviewees indicated that the lack of top management involvement and support when deploying LSS could affect its success. *'You will always have a problem if there is no involvement of the facility head and concerned unit heads if you are not involving them you cannot get any response. Always involve them, take their support with you, then you go with that. If you are not involving in any program, then none of the programmes can succeed.' (I8).* The existence of top management is perceived to be an important milestone while deploying LSS methods as it's a testament of their commitment; however, the lack of such support could affect its consequent success as observed by one interviewee.

> *'My observation has been for 11 years in UAE. And you know, how many things I've done, and how many lectures and how many training I delivered. the number one support are the front line, and the number one blockage and delay and inhibitors are not the leadership but the top leadership' (I5)*

Furthermore, the lack of knowledge among top management is another barrier that was reflected during the interviews.

> *'So our number one resistance was leadership. And it's a culture of leadership. And the most important reason for this is a lack of knowledge. They simply didn't know what is lean and what is Six Sigma, you know, and what would it add as a value. So they were extremely sceptical.'(I5).*

One of the interviewees also mentioned that instability of top management is another challenge facing UAE hospitals, effectively hindering the success that could be oriented by LSS methods.

> *'We have, you know, change, lots of changes in leadership within the hospital and at all levels. So, this may affect, you know, the vision because you have today you start something with one leader, he's changing tomorrow. So, you have to start again and again.' (I6)*

Another issue is the accessibility of top management and functional leaders. One of the interviewees explained that their lack of accessibility presented issues during LSS implementation.

'I have to chase every leader within those departments to release their staff and, you know, make them dedicated and committed to the project.' (I2)

Therefore, there are 4 focus areas to overcome when it comes to top management support. They include involvement, knowledge of LSS methodology and its benefits, stability and accessibility.

Lack of understanding of statistics

Some interviewees argued that the lack of statistical knowledge was a major challenge for LSS implementation. One interviewee described using advanced statistical tools in her hospital as talking Chinese in an Arabic hospital.

> *'We don't have good statistical knowledge in our organization so to use advanced statistical tools, it will be like talking Chinese in an Arabic hospital.' (I1).*

One of the interviewees posited that in the UAE, the lack of staff statistical knowledge might stem from the fact that the healthcare sector staff come from different countries and educational backgrounds.

> *'I believe the maturity of LSS will be a challenge because we have 47 Nationalities, people coming from different schools of learning, nurses coming from India, from the UK, from Pakistan, from all nationalities people working in quality are not too many people in hospitals clinical people are not statistically oriented ' (I1).*

> *'I attended a couple of sessions now because since university we do not take or work in statistics. Every time you to refresh your memory.'(I6)*

It can be argued that a certain level of statistical knowledge and understanding is required to implement Six Sigma methodology and utilise some of the tools like process capability and control charts. Such a lack of understanding can become a barrier.

Lack of resources

Some of the interviewees mentioned that the lack of resources, such as time, staff or funds, could lead to serious issues during LSS deployment.

> *'So any problem comes to think on these lines to sort out the problem, because we are talking about resources, right. So there's always a resource crunch in an organization.' (I2)*

The lack of software to analyse statistics is another challenge, as reported by one of the interviewees. This issue could relate to the lack of resources (e.g. Funds) to purchase statistical software licenses.

> '*The other obstacle that we don't have the analysis software. For example, if I want to utilize software for six sigma , I don't have it, I have to get it from outside like Minitab which was for available for a short period of time.' (I6).*

Another interviewee indicated that it was difficult to get clinical staff (physicians and nurses) who were willing to give their time to participate in LSS meetings, in consideration with the usual requirements of their jobs.

> *'Six Sigma requires a lot of resources and dedicated time, and you will not get clinical people to get more involved you will get some of the nurses and front line staff. But you cannot get physicians working in these tools and dedicating time to you including meetings.' (I1)*

One of the major reasons that hinder the commitment of clinical staff is due to the perceived burden they may experience. LSS practitioners can get better collaboration by identifying projects that will satisfy clinical staff by improving the efficiency of processes that would benefit them. A stakeholder analysis with an appropriate communication plan could be useful at the outset of the project (Caldwell et al. 2005).

Not Linking LSS to financial benefits

Various interviewees mentioned that the lack of awareness about the connection between LSS processes and relative financial benefits posits a barrier that may result in poor support from management and staff. There is a better chance for the success of LSS projects if it is effectively linked with organisational savings or avoidance cost.

> *'The third thing is it has always been challenging to link quality improvement to money, and that has been an ultimate challenge because the problem is I can put a figure on problems, patient complaints, patient filing a lawsuit, you know, you at the end of the year, you can say, Well, I paid those patients that much to settle the lawsuits I had to do those discounts for this, insurance denied me this, so you can put a figure but how can how, but how can you put a figure on all the things that you prevented it from happening?' (I2).*

However, it would be difficult to quantify some projects projected financial benefits. As a result, the challenge would be to estimate an LSS project benefit by attaching a dollar value to it, as explained by one interviewee:

‘How can I prove to my managers that because of an intervention prevented 60-70 medication errors. Okay, how can I get to that figure?. And even if I got the figure and how can I put a dollar value on them?’ (I2).

It is apparent that practitioners share the same concerns as academics when it comes to the challenges of measuring financial benefits (Sony et al. 2018).

Lack of communication and use of jargon

The lack of communication on LSS projects is mentioned by one of the interviewees:

‘We have big gaps in communication. So that was another improvement initiative…‘I don't think they know enough about Lean Six Sigma.’ (I3).

Resonating with the same concept, using jargon (e.g. LSS acronyms terminology) during communication could hinder the message of the importance of LSS and its benefits as one interviewee explained:

‘Avoid jargon (In Arabic don't be philosophical) you know use simple (language)…. and the third thing and I wrote it on the paper is avoid jargon. Avoid Kaizen, avoid Lean, just say no waste, minimize waste, you don't get more efficiently meaning that we're looking at the effectiveness and resources Hey, that's how I did that.’(I5)

Some interviewees felt that the lack of advertising on LSS projects could lead to confusion. For example, sharing success stories of LSS implementation among local hospitals could encourage them to implement the same within their hospitals.

‘..more advertising on the (LSS) projects that were done. We don't know what's happening in the hospital. Sometimes, unless we ask. I know quality department has now been advertising the KPIs, But still, we don't know what are the quality improvement projects that are happening.’ (I7)

‘We didn't (know of) have any hospital that has adopted Six Sigma that a role model that everybody replicates or everybody sees it, I think this is what is missing.’ (I1)

> *'We have to identify and show them some example. Initially. We have to show always some success stories, really easy flowing. So, you have to do some pilot study with one big unit Yes, you go with one department you do a small pilot study and show them this all implemented so people can easily replicate in their units.'(I8)*

When it comes to communication, hospital staff want to use simple language. They want to see success stories of LSS in other hospitals and theirs so they can validate the benefits of LSS programmes.

Individual themes:

Resistance to change

Other barriers included resistance to change, as LSS is considered a change programme that challenges an organisation on how it operates and applies new methods. According to one of the interviewees:

> *'And some people who have been around for quite a while, they don't even want to learn something new, and they say it has been working, you know, why, why change the people honestly, would say, Oh, he's new and wants to show his impact so he is bringing something new.' (I2)*

In organisations, changes alter the behaviour of people towards learning or adopting a new style for the functioning of an organisation. Staff want to understand the impact of these changes and if they bring something new.

Lack of data and poor data collection methods

One interviewee reported that the lack of data and poor data collection methods was a barrier when implementing LSS:

> *'I'd start with the, with the critical element of having a proper data collection analysis system, because, you know, we're living in a world that is pretty much data-driven. And now data is referred to as the new audience. So, so if you don't have the data you will be or as good as a blind organization and data is tricky,*

you know that. It can be analyzed, in so many ways to highlight this or that, but, but, in Lean Six Sigma it is very critical to have a very robust data collection system and analysis system.' (I2)

The mentioned barrier has been highlighted in various studies as one of the top barriers in different continents (Antony et al. 2018). If an LSS project does not have quality data available, it's probable that the entire project might fail.

6.13.2 LSS CSFs

Interviewees were asked about the proper behaviours to support the deployment of LSS at their hospitals. The following sections will present the detailed findings and indicative statements for these factors. Figure 6.4 captures the number of citations that were mentioned with reference to these factors providing some rank for the importance of these factors (The author counted multiple citations of the same CSFs within interviewees transcripts hence the frequency number was higher than the number of interviewees, i.e. 8). Closer inspection of the charts shows that top management commitment and training and education are the top factors. These seem to support many previous studies results. The following sections will discuss some of these CSFs and their meaning within the context of UAE hospitals.

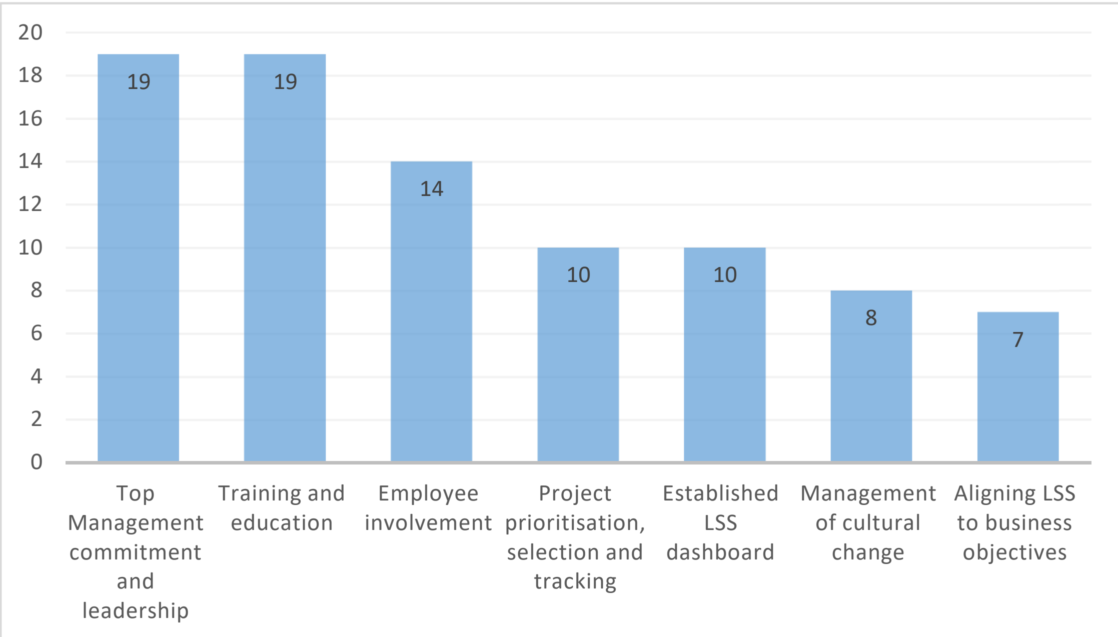


Figure 6.4: CSFs citations during interviews
Source: Author

Top Management commitment and leadership

Although, various studies mentioned that the commitment and leadership of top management is one of the most crucial factors during LSS deployment (Albliwi et al. 2014; Sreedharan and Raju 2016; Brun 2011; Desai et al. 2012), these studies may not provide clear examples on on how top management support and leadership are exhibited. While the results of the qualitative analysis in this study resonated with these findings, it presented a more in-depth analysis of what is expected from top management. For example, interviewees said:

> *'…the most important factor is what the leader sends as a message and behaves on a daily basis.' (I8).*

> *'..the leadership is involved into the day to day and the quality Council, which the leadership participate in it, the CEO group participates in the quality council where all the quality initiatives, the performance measures, also presented' (I8)*

> *'..leadership commitment is very important. commitment and buy-in of the, of the concept now, you know, our leadership commitment to quality and patient safety is very high.' (I6)*

> *'All the leadership is very much pro-quality improvement.' (I2).*

These results showed that hospital leadership needs to communicate daily with regards to quality programmes, including LSS. Some interviewees attributed the success of their LSS programme to the daily involvement of the leadership throughout the LSS programme and not just during the initial few stages. Additionally, the presence of the quality council, formed from senior management members, could play a significant role in supporting LSS. Interestingly, this point was raised by Juran in his early teachings (Juran et al. 1999). Also, the results reported that leadership support is expected from all leadership levels in the hospital and not just from one leadership level.

Training and Education

One interviewee described the journey on how they started LSS by offering training on PDCA, which created a natural transition into Six Sigma DMAIC.

> *'We started educating people about this PDCA. So next, we should start when we are going for the Six Sigma we met, we need to educate the people the process the DMAIC, we need to explain how to do DMAIC, what is SIPOC all these things. we need to educate the people then we come up with ideas to implement it correctly.' (I8).*

Hence, having an education programme in place within the realm of an organisation is critical. For successful implementation of Lean and Six Sigma, many tools have to be learned. The success of LSS significantly depends upon the learning of the staff and its effective usage during the DMAIC phases as alluded by the following interviewees:

> '*And then they also need to have good skills in terms of like, analytical skills, basically. So education and training is critical.' (I4)*

> *'Continuous training is very important; you need to remind people about utilizing these tools.' (I6)*

> *'Second thing is there should be enough resources from an educational point of view because to link it back to what I mentioned; you should have a very strong educational program or enough resources to send people for training outside. ' (I2)*

It is essential for the employees to have sound knowledge about problem-solving and statistical tools to execute LSS projects in an effective manner . It is also apparent that education and training are linked by the availability of resources (e.g. funds) and top management support.

Employee involvement

Many interviewees attributed the success of their LSS initiatives to employee engagement and buy-in. Once the employees realise the benefits of LSS programmes, they can effectively participate in the projects. One interviewee said:

> ‘*Employee engagement, that's most important thing.’ (I4).*

One of the major challenges in the realm of a hospital is to acquire a cross-functional team, belonging to different levels of staff and job descriptions, willing to work together. There are administrators, nurses and physicians (Caldwell et al. 2005), and it’s a task getting them all engaged with a streamlined motive. In order for an LSS programme to work, all levels need to be involved, as described by an interviewee.

> *‘Yes. doctors, nurses, paramedics, non-clinical staff members, everyone, so we would (Involve) touch 564 people out of this 1400 at that time for the training and so what we tried to do with we have, you know, different engagement programs.’ The success lies in the commitment of the people.’ (I4)*

An Interviewee reported that staff involvement process during the early stages of LSS programmes which will allow its smooth launch and deployment is needed.

> *‘most important thing that we took care of that we paid attention to that to involve everybody in the planning stage, not the implementation stage like as we were planning, we invite everybody to be with us and to talk about their needs everybody acknowledges that change has to be done.’ (I7)*

Project prioritisation, selection and tracking

One interviewee said that the hospital uses a risk matrix to select projects during the initial stages of LSS that usually provide focus throughout the entire project cycle.

> *‘And based upon risk management and a two by two matrix, okay, and things like that, and high volume problems and, you know, high-risk failure.’ So defining then measuring the magnitude of the problem, how big is the problem is, then analyzing. So what are the analytical tools to be used, and also this week to*

discuss the group exercises, we took some examples of the live projects, what they are going through, so actually, those 18 are going ahead at the same time.'(I4)

'And most important is the choice of the area work to implementing success. Because if you are planting a tree with the wrong soil , I tell them make sure you chose this based on the priority grid and I usually recommend the 1987 Mayo Clinic engineering department priority grid.' (I5)

A number of tools can be used to select projects based on their focus on risk, the scope of problem and areas of implementation. One interviewee used a healthcare priority grid in the selection process as described above.

In one case, the interviewee thought that breaking big projects into smaller ones could enhance the success of LSS projects.

'You can't boil the ocean. They want to fix everything and want it quickly, in the three months tomorrow. Okay, this is I hope you agree this is my number one because if you're not prioritising, you're losing.' (I5)

Attempting to 'boil the ocean' is an impossible task, but if broken into small pieces that could get the job done. This is an important step that needs to be considered during the project scoping and selection process.

Another interviewee emphasised the concept of having clear measures and indicators in hospitals to identify the areas of concerns which could help in choosing the appropriate projects:

'We previously do measure turnaround time for ultrasound reports. And it was when we started putting it into a picture so staff can actually see the picture, it was all red. So then the alarm bell started going on.' (I3)

Established LSS dashboard

Business practitioners argue that it is hard to manage and improve what you do not measure (Kaplan and Norton 2005). One of the interviewees postulated that the presence of indicators to measure the performance of the project could enhance the success of LSS methods:

> *‘We ask every department to submit two quality improvement projects annually . Okay, but we are still not successful in that and we had a chance last year doing the KPI. So we have now a very nice KPI dashboard.’ (I7)*

Another interviewee said that the success of LSS is linked to clear project tracking by assigning responsibilities to LSS team members.

> *‘Give them specific responsibilities and accountabilities and the KPIs so that we have to comply with that.’ (I3)*

Management of cultural change

Deploying an LSS programme requires cultural change and organisational transformation in mindset. Thus, an organisation must transform and undergo a significant ‘psychological change’ which could lead to the success of an LSS programme. One interviewee asserted that hospitals need to assess their readiness for change and make use of a change deployment framework such as Kotter’s 8 steps (Kotter 2012) to establish the urgency of change while deploying LSS programmes.

> ‘*Assessing organisation for readiness for change is key. And I don't know about criteria that are objective, and I can learn from you. Yeah, and how do you know that in the sense of urgency that Kotter talks about, people don't see it, because they don't see they say, we've been doing it the same way. why change?’ (I5)*

Another interviewee said there is a need to assign an internal change agent or catalyst for LSS.

> *‘It needs more internal Change Catalyst, someone we can initiate change and maintain it as well.’ (I6)*

Various interviewees mentioned that it is critical for the staff to understand the need to change and its relative impact on them. If the staff is on board for a change, LSS projects will have better chances of success.

'People (say) that we've been doing the same thing. why would you want to change, I mean, the usual story change is really difficult. And some people are in the comfort zone, and they have certain people coming in and trying to change often challenging, And this is why if you can get some wins, you get a couple of successes and actually get that to spread internally that actually helps.'(I3)

'As you know, change when it happens to have has to go through several stages, and several, and even if we do the change, we need the staff let them buy into the new process and not be resistant. So this is another important aspect, like the management support and resistance to change.'(I7)

Aligning LSS to business objectives

Having a clear alignment between the vision/hospital strategy and the LSS programme is critical to the success of LSS projects as it gives importance to these projects. Various interviewees signified the importance of the connection between strategy from LSS programmes.

'You need strategic guidance, and that would flow probably from the vision of the organization. And that would require a high-level analysis of what are we going to focus on, right. And when this happens, then you are given you're given a target.' (I2)

'So first of all, we need to see the objectives, the vision and the mission of the company, the company wants to go, what is the commitment level of the leaders?' (I4)

'Maybe Lean Six Sigma is more fit for hospital-wide projects that have an impact on the whole system and where the management will support you with resources to achieve the strategic target.' (I1)

According to one interviewee, having a quality plan derived from strategy and linked LSS can further the success of LSS.

‘We put Six Sigma as part of our quality plan. So, yeah, if you've got a quality plan, it's one of the methodologies that is recommended to these because we really wanted to encourage people.’ (I6)

Additionally, some interviewees indicated that having LSS linked to strategy will ensure that resources are well allocated to LSS.

‘With a link to objectives, resources will be aligned, and resources will be given from the management dedicated time and effort will be allocated. if you have the strategic management support you have their resources, then you have everything will be online, so it should be linked to a strategic objective.’(I1)

One interviewee explained that their top management and board members were interested in supporting LSS projects as they could link them to the hospital strategy. Thus, it can be argued that the projects that are effectively linked with strategy can gain the support of top management.

‘Our board members, three of them come and visit us every month, and they spend four to five days with us, so they're in the office and would be so being involved in anything that actually makes us a better organization and more efficient. So that comes from the strategy.’(I3)

The view from the respondents shows that LSS tend to be a top-down approach. These findings are similar to a great extent with previous studies (Albliwi et al. 2014; Laureani and Antony 2012). Furthermore, the results of the qualitative study also resonate with the comprehensive review of CSFs related to healthcare conducted by Antony et al. (2018). This indicates that the UAE healthcare is not substantially different from other sectors and countries.

During the interviews, several issues emerged relating to LSS implementation. The following sections present these findings.

Accreditation

Accreditation seems to be a driver for hospitals to adopt continuous improvement methodologies, although it does not specify the type of the methodology. Interviewees indicated that accreditation could play a vital role in supporting continuous improvement initiatives.

> *'Accreditation is in our genes. (However), JCI does not require a specific quality methodology. It just requires some system for quality improvement might be lean and might be PDCA or PDSA and does not specifically ask for an initiative that you should have a system for quite a moment that's adopted by staff'. 'JCI is not prescriptive. It is descriptive.' (I1)*

Also, during the interviews, it was apparent that some hospitals with JCI accreditation are implementing less sophisticated continuous improvement techniques. For example, Hospitals are using Deming's FOCUS-PDCA, while others are implementing the structured LSS-DMAIC approach. FOCUS-PDCA is a systematic process improvement method initially developed for the healthcare industry that was designed by the Hospital Corporation of America (HCA). The FOCUS elements are: Find a process to improve, Organize to improve the process, Clarify current knowledge of the process, Understand the source of process variation and Select the process improvement.

Areas of LSS implementation

During the interviews, many reported that certain areas are more suitable for LSS implementation than others. For example, it was perceived by some interviewees that LSS projects work better in administrative areas and processes that involve waiting times, such as the pharmacy and emergency department (ED).

> *'So it is better to initially start (Six Sigma) with administrative things okay. Like you can see radiology reporting, pharmacy dispensing, so these are not pure clinical, but it is a link of clinical and administrative.'(I8)*

> *'The best projects for LSS is waiting time and ED waiting time for claims and turn around time will be the best projects for turnaround and patient flow so that we can pick them up. I believe Six Sigma will implement more with laboratory with IT. With areas of high transactions.'(I1)*

Other areas that were mentioned included laboratory and billing.

'The examples from the world that I have been exposed to are related mainly to the lab. Yeah, and with the pharmacy. because they issue medication for a prescription or they issue results for a blood test. So it works.' (I2)

'Billing is a big area of concern. you know because patient you have to wait for insurance you know maybe get started on this day, and somebody forgets to call the next day and then the next day they forget to call the page you know so there are all those delays you know which if you had a proper system you wouldn't have those delays.' (I3)

An excellent source to identify areas for implementation could be to examine customer complaints, as explained by one interviewee.

'So, yes, you can start with complaints that would be a good project to start with areas of complaints and now with severe competition customer satisfaction will be in one of the areas everybody will look at.' (I1)

Hospital measures and the impact of LSS

When asked about the key hospital measures and if LSS programmes had an impact on those measures, interviewees indicated that LSS had a positive impact. The measures that were positively influenced included readmission rates, prescription errors, and waiting time.

'Yes, there has been an impact when I see less prescription errors or lesser number of falls or fewer patients coming back to readmission 'So there has been a, an impact in the sense of decrease in the figures.'(I2)

'Actually, it should have positive impact because any time for example, you know, the waiting time where we had issues in waiting time and since we have implemented one of the projects you know the waiting time that we were not meeting previously we start meeting the KPIs, and of course it has an impact on you know, the patient or the patient experience as in general in every project. If I can, I can show you every project we have utilized the tools, and it is showing improvement because if a KPI is deviating from what is expected, then we have to implement and quality improvement project.' (I6)

When asked about the measures monitored in UAE hospitals, many common measures emerged that are consistent with global healthcare studies. These included patient satisfaction, infection control, readmission rates, mortality rates, patient safety, medical errors, patient falls and turnaround times.

> *'We have all measures classified into structure, process, process outcome, so each department, we have measures, there's no department without measures., there are some mandatory measures from the regulators, some from JCI. Apart from that, we identify the areas of improvement for their departments…patient safety measures Okay, Then readmission rates, mortality rates, patient safety, readmissions, mortality rates, turn around time.' (I8)*

> *'We refer to falls, pressure ulcers, medication errors, communication errors, patient identification errors.' (I2)*

> *'Patient satisfaction is monitored through a third-party provider Press Ganey. Yeah and we also look at infection control related, mainly number of hospital developed infections whether post-surgery whether related to a catheter, number of patient complaints as required from the Dubai Healthcare City and part of the database of KPIs, waiting time in ED and in operations theatre as an average.' (I2)*

> *'Customer satisfaction, and patient experience in general, we do monitor process and outcome measures. For example, a process measures look at the waiting time we look at referrals, you know, waiting time and we have our patient satisfaction surveys.' (I6)*

<u>*LSS tools and methodologies*</u>

During the interviews, it was evident that many tools and methodologies were used within the context of continual improvement, such as Lean and Six Sigma programmes. One methodology that seems to be well known and deployed is the FOCUS-PDCA. Many interviewees attributed its popularity to its simplicity and the easiness for the staff to understand and explained below:

'We adopt here the FOCUS-PDCA. Yeah, okay. there are multiple tools in quality. one we adopted initially is the PDCA methodology. mostly (because) most of the hospitals are using this method PDCA. It is easy for education,(4 letter acronym) and, to pass to a group of people.' (I8)

'…(it) has always been the typical FOCUS- PDCA very, very simple, I'd say but also very systematic because it doesn't require a lot of training for the front line staff at this intuitive it makes sense, you can give it as an example in your daily life.' (I2)

'PDCA wasn't familiar with our staff at the hospital projects, but we've got the staff making posters on FOCUS- PDCA and I tried to keep it very, very simple at this stage so that we have lots of pictures before and after.'(I3)

Other tools that were mentioned included FMEA, 5S, Five-Whys, Fishbone graph, process mapping and flows, brainstorming and benchmarking. This study revealed that hospitals tend to use non-statistical tools, which confirms the barrier point advanced earlier.

Emerging themes on LSS in UAE healthcare

A number of interesting themes emerged during the interviews. A key theme is that Lean seems to be more dominant in UAE hospitals than Six Sigma as alluded by the following interviewees:

' Lean thinking has been a lot in the discussions in the quality committee.' (I2)

'We can speak the language of waste (easily). I can say we are not mature enough(Six Sigma). We are still developing the infrastructure, developing their knowledge (Staff) and sharing the knowledge.' (I1)

'It is extremely important to realize that improvement in general PDSA to a certain extent and Lean and Six Sigma to a huge extent is markedly misunderstood, underused in UAE. UAE is an amazing country and has the potential of leading in it instead of using it.' (I5)

‘I can see that Lean is in place so that all the tools of lean are still people utilize it, more frequent but six sigma to go and do six sigma, the formal methodology has flattered a little bit.’(I6)

‘Now, from a systematic point of view, we're not implementing the DMAIC or doing the analysis for the standard deviations?’ (I2)

Feedback above shows that Six Sigma is not understood well and hence underused in the UAE. Respondents indicated that UAE hospitals find it easier to implement Lean programmes that can be used as a useful gateway for hospitals to engage staff in improvement initiatives.

‘Lean is eye-opening, I consider it learning to see, planning to see, when they start looking at waste and yes, it is happening in our department. So when we reflect and say changing the culture, this is the reflection part of the all the exercises, how does it affect you. While in Lean you have a couple of meetings, people get involved, the other staff can work with you. Lean is for everybody.’(I1)

‘So like that we do ourselves as I told you, there is no a specific approach like Lean or Six Sigma.’ (I8)

‘And that is the lesson learned that you should always start with lean. people accept it a lot easier. because in lean, people recognize the waste, they accept the waste, they know that you know overproduction and waiting, especially those are the ones that they can see.’ (I5)

Some interviewees felt that the LSS model should be more catered or customised to healthcare.

‘My experience with LSS is that it is more catered, that this is my impression. And then I'll give you the impression of the quality council is that (they feel) it is more catered towards products. When it comes to health care processes, like patients, hospitalization stuff, I find it a little bit challenging to cater to that scope to the methodology (LSS).’ (I2)

One interviewee felt that Six Sigma belt training format creates arrogance and could hinder LSS implementation.

> *'When people have belts (training) they become arrogant. Black belts say 'I know everything'. Please tell everybody to stay humble as people.'(I5)*

Linking LSS training to actual projects can get people excited to get some experience doing actual projects leading to certification.

> *'…actually, everybody was so enthusiastic at the beginning, after the (training) course, you know, everybody's starting to be very excited and they started implementing the project that they have, as part of the training to complete certification, and they were very good projects.' (I8)*

Lean does appear to yield quick results. One of the concerns is that people wish to see improved results quickly, putting pressure on LSS projects as reported by one interviewee:

> *'People want results directly, to be honest, and sometimes we are forced to move forward with the steps although if we do it systematically, it will help us more like looking at the data and going into the Minitab and analyzing all these statistics before and after, but sometimes you are bounded with time.' (I7)*

Interviewees raised the issue of the sustainability of LSS projects. Some were concerned that projects will start at the beginning but may falter at later stages, making it a superficial initiative or another flavour of the month.

> *'It is highly recommended it's a very, it's an excellent tool. And it's very structured, you know,but we need to focus at the last stage. Yes, sustainability is an issue in hospitals in general. You implement a project today. It is sustained for a period of time and then it fails again. So and it's global, it's not just not related to this hospital, but continuous training and keeping the people in the loop of you know, it's very, it's very important. Staff to implement at least two projects to include six sigma in a year.'(I6)*

'When we are done with a quality improvement project like we talked about sustainability is very important. And this is something sometimes that is lost because the project has been done, so how long the project should be done, and all of this, this is very important also.'(I7)

LSS practitioners can maintain momentum by supporting continuing education, creating awareness about the success stories and establishing targets and incentives for staff to facilitate their participation set targets and incentives for staff who participate in LSS projects.

One interviewee was somehow critical of the idea of improvement and called it a 'dream' that requires enablers to ensure that the results are realised. This idea shows resemblance to the 'pink factory' concept discussed by Baxter and Hirschhauser (2004) where organisations could be claiming they are implementing and realising improvement results while they are not.

'…Number one and most importantly (Is that) improvement itself is not a priority in healthcare system. It is a dream that people are not enabling people to improve. In other words, everybody, in theory, wants to improve. everybody wants to lose weight, be healthy, have a great organization with amazing income, amazing quality and safety and patient experience engaging everybody and everybody is involved. Everybody is happy (To become) number one employer etc. etc. But the concept of enabling everybody wants results without enablers That is why the EFQM model or the one from the United States (MBNQA) which is related bring something that we don't talk about neither in PDCA nor in lean nor in six sigma which is the concept of results enabler.' (I5)

6.14 Summary of qualitative results

The above sections presented the findings and the analysis of the exploratory semi-structured interviews. The interviews helped to explore the various intricacies of LSS deployment, CSFs, their relative barriers and the hospital measures. The author identified 25 codes (nodes) and allocated them to 6 themes, as shown in Table 6.14.

Table 6.14: Themes and topics of the interviews

Theme	Codes
Accreditation	Accreditation
Areas of implementation	Areas of LSS implementation
Critical success factors	Aligning LSS projects to business objectives
	Availability of resources (financial, time)
	Communication of information
	Employee involvement
	Established Lean Six Sigma dashboard
	Incentive programme
	Linking LSS to customers
	Linking LSS to employees
	Linking LSS to suppliers
	Management of cultural change
	Organisational infrastructure and cross-functional teams
	Project Prioritisation selection, management, and tracking
	Top management commitment and leadership
	Training and education
	Usage of problem-solving and Statistical thinking and tools
Impact of LSS	Hospital measures
LSS extent of application	Lean implementation
	Lean Six Sigma implementation
	Lean Six Sigma integration
	LSS Status
	Six Sigma implementation
	Tools and methodologies used
LSS Launch	Barriers

Source: Author

6.14.1 Discussion of key findings

While section 6.11 reviewed the survey findings and compared them with the literature, this section reviews the findings from the interviews.There are a number of key findings in this section that are discussed below.

CSFs and barriers in UAE hospitals

Many of the findings were in consensus with previous LSS CSF research (Alsmadi et al. 2012; Douglas et al. 2015; Albliwi et al. 2014; Antony, Antony, et al. 2007; Antony et al.

2018). For example, Interviewees held a common consensus hat the following CSFs could support LSS implementation at their hospitals: top management commitment and leadership, training and education, employee involvement, project prioritisation, selection and tracking, established LSS dashboard, management of cultural change and aligning LSS to business objectives. While many previous studies have raised the issue of top management and support, this study was different as the interviews expanded the existing literature by clarifying what is meant by top management and leadership. Interviewees highlighted that expected top management behaviours are daily visible activities, being accessible, participating in quality council and showing a clear understanding of the LSS methodology. Furthermore, most LSS CSFs studies (Kumar 2007; Desai et al. 2012) were conducted in one country and assumed stable work conditions while this study investigated the UAE context where more than 200 nationalities reside and work. The interviews added to the literature two new CSFs. These were the stability of the workforce and job security as factors to enhance staff engagement and participation during LSS initiatives.

A number of LSS barriers were reported by the interviewees, such as lack of top management involvement and support, lack of understanding of statistical tools, lack of resources, not linking LSS to financial benefits, lack of communication, resistance to change, lack of LSS success stories in local hospitals and lack of data availability and poor data collection methods. These results confirmed the LSS barriers in the literature (Antony et al. 2018; Albliwi et al. 2014) while revealing the following additional barriers: lack of sustainability of LSS, lack of a holistic approach to deploy LSS and the lack of advertising of LSS success stories. The issue of CI sustainability has been discussed in the literature and requires humans changing their behaviour over an extended time (Sony et al. 2019; Wiklund and Wiklund 2002). Hence hospitals must pay special attention to address how staff behaviour is changed to support LSS initiatives. Interviewees reported that there must a clear alignment between the hospital vision, strategy and LSS programmes.

The UAE diversity challenge

Previous LSS CSFs studies assumed similar staff backgrounds. However, the UAE presents another challenge where 88 per cent of its population are expatriates (Global

Media Insight 2019). A typical hospital will have staff originating from over 20 countries. Their diversified work cultures and educational backgrounds can present challenges during the deployment of improvement initiatives, as indicated by the interviews. Within the context of the UAE, the interviewees highlighted the unique nature of the transient workforce where staff, including top management, may not feel stable at their jobs hence affecting their commitment towards CI and LSS initiatives.

The extent of LSS implementation

Results revealed that the integrated LSS approach is not fully employed in UAE hospitals and hospitals are selectively using some of Lean simple principles and tools as they tend to find them easier to communicate and teach while Six Sigma adoption is challenged by the lack of understanding of statistics, lengthy adoption and lack of ability to link it to financial benefits. Broadly speaking the interviews discovered that the implementation of a combined LSS approach within UAE hospitals is at a nascent stage, and the understanding of the methodology and its tools are still facing challenges.

Hospital measures

Several hospital performance measures that may be linked to the outcomes of LSS were mentioned, including patient satisfaction, waiting time, prescription errors, infection control and readmission rate. These outcomes were in agreement with Antony et al. (2018) global systematic literature review on healthcare where patient satisfaction, speed/timeliness (Decrease length of stay, decrease waiting time, etc.), revenue enhancement, cost savings and defect reduction such as medication error reduction were identified as the top outcomes. This is no surprise as many hospital measures are becoming universal, given the accreditation schemes and the unification of healthcare standards. Interviewees reported some success stories of LSS implementation and thought that LSS has a positive impact on their hospital measures. This confirmed the results of the quantitative analysis in section 6.11.

In the following chapter, the ISM group analysis is presented and discussed.

CHAPTER 7: INTERPRETIVE STRUCTURAL MODELLING ANALYSIS

7.1 Introduction

Although LSS CSFs are widely discussed in the literature, there is a paucity of research when it comes to the understanding of the linkages between, and hierarchical relationships among, these CFSs (Dubey et al. 2016). Such hierarchical frameworks can provide valuable information to practitioners when deploying LSS (Soti et al. 2010) to understand the importance of these CSFs and how they relate to each other during deployment. In this study, the aim of the ISM exercise was to provide a more detailed understanding of the causal factors that enhance LSS deployment. The ISM group session aimed at addressing the 4th study objective, namely, to develop a framework for LSS deployment in UAE hospitals clarifying the interdependencies between the CSFs. Nine participants, 4 from healthcare and 4 from other sectors, participated in the session. Figure 7.1 shows the group in action.

Figure 7.1: ISM group session

7.2 ISM output

At the outset of the ISM exercise, the CSFs operational definitions, shown in Appendix B, were explained. Each participant ranked the top 5 of the 15 CSFs, and as a result, Figure 7.2 revealed the top 11 CSFs. Top management commitment, aligning LSS projects to business objectives, understanding LSS methodology, management of cultural change and availability of resources ranked as the top 5 factors according to the views of the LSS practitioners. Although the sample size was small, these results further confirm the findings from this study main survey and previous literature findings.

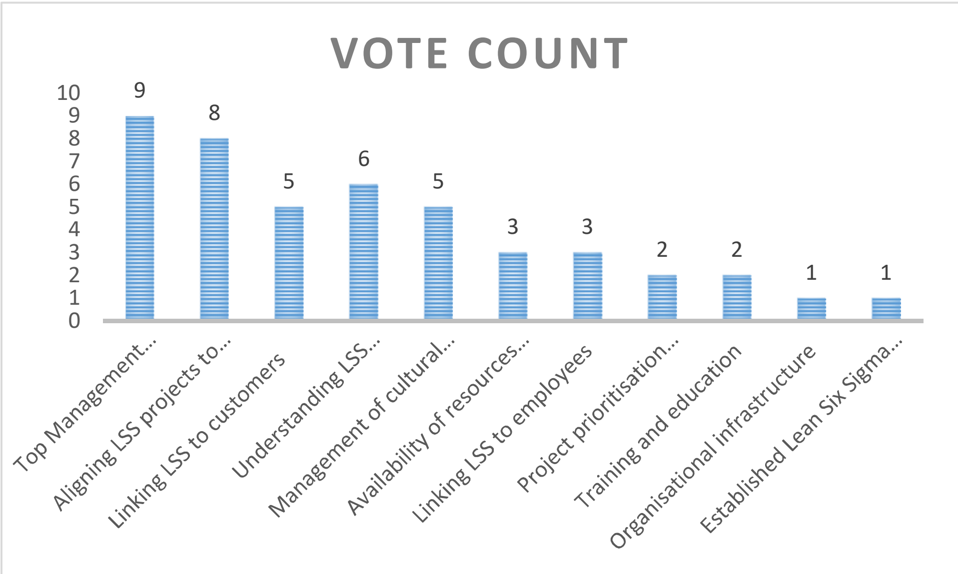


Figure 7.2: LSS experts ranking on CSFs
Source: Author

The development of the ISM model followed the approach outlined earlier in the methodology chapter in section 4.12.7. The 9 LSS experts were engaged in discussions to establish the causal relationship between the CSFs within a hospital context resulting in the initial Structural Self Interaction Matrix (SSIM) table, shown in Table 7.1. The table was transformed into a binary matrix, shown in Table 7.2.

By applying the transitivity rule, as mentioned in section 4.12.7, the final reachability matrix was produced, shown in Table 7.3. After which the process of identifying the hierarchy of the CSFs levels was done. The reachability set consisted of the factor itself and other factors, which it influences. The antecedent set consists of the factor itself and other factors, which may influence it. After deriving the reachability and antecedent set, their intersection sets are derived for all factors. The CSFs having same reachability and intersection set are assigned as top-level factors and considered as the first iteration. After finding level 1, it is then removed for finding further levels. This iterative process will be continued until the level of each factor is found. Seven iterations were identified in this study. From the level partition iteration 1 to 7, we can conclude that the top and bottom level factors. ‘Linking LSS to suppliers’ and ‘established LSS dashboard’ are identified as top-level LSS factors compared to other factors, while ‘top management commitment’ and ‘management of cultural change’ are at the bottom level from all these 15 LSS factors. The Tables in Appendix O illustrates the iterations and the identified levels.

After establishing the digraph, it was shared with the ISM group to discuss any conceptual inconsistencies. The group updated the digraph, and the final LSSDFH was drafted, shown in Figure 7.3.

Table 7.1: Structural self-interaction matrix (SSIM)

CSF	STMC	SMCC	SABO	SULM	SCOI	SOIN	SAOR	TLLE	TIPR	TTED	TUPS	OESD	OLLS	OPPS	OLLC
STMC		X	O	O	V	O	V	O	V	O	O	O	O	O	O
SMCC			O	O	O	V	V	O	V	O	O	O	O	O	O
SABO				O	O	O	O	O	O	O	O	O	O	V	X
SULM					O	A	O	O	O	O	X	O	O	O	V
SCOI						V	O	O	O	O	O	O	O	O	O
SOIN							O	O	O	O	O	O	O	O	O
SAOR								O	O	V	O	0	O	O	O
TLLE									A	O	O	O	O	O	V
TIPR										O	O	O	O	O	O
TTED											V	O	O	O	O
TUPS												O	O	O	O
OESD													O	A	O
OLLS														A	O
OPPS															A
OLLC															

Top Management Commitment (STMC). Management of cultural change (SMCC). Aligning LSS projects to business objectives (SABO). Understanding LSS methodology (SULM). Communication of information (SCOI). Organisational infrastructure (SOIN). Availability of resources (financial, time) (SAOR). Linking LSS to employees (TLLE). Incentive programme (TIPR). Training and education (TTED). Usage of problem-solving and Statistical thinking and tools (TUPS). Established Lean Six Sigma dashboard (OESD). Linking LSS to suppliers (OLLS). Project Prioritisation selection, management, and tracking (OPPS). Linking LSS to customers (OLLC)

Source: Author

Table 7.2: Initial binary reachability matrix for CSFs

CSF	STMC	SMCC	SABO	SULM	SCOI	SOIN	SAOR	TLLE	TIPR	TTED	TUPS	OESD	OLLS	OPPS	OLLC
STMC	1	1	0	0	1	0	1	0	1	0	0	0	0	0	0
SMCC	1	1	0	0	0	1	1	0	1	0	0	0	0	0	0
SABO	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1
SULM	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1
SCOI	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
SOIN	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
SAOR	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
TLLE	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
TIPR	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
TTED	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
TUPS	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
OESD	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
OLLS	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
OPPS	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
OLLC	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1

Source: Author

Table 7.3: The final reachability matrix

CSF	STMC 1	SMCC 2	SABO 3	SULM 4	SCOI 5	SOIN 6	SAOR 7	TLLE 8	TIPR 9	TTED 10	TUPS 11	OESD 12	OLLS 13	OPPS 14	OLLC 15
STMC 1	1	1	0	0	1	***1****	1	***1****	1	***1****	0	0	0	0	0
SMCC 2	1	1	0	***1****	***1****	1	1	***1****	1	***1****	0	0	0	0	0
SABO 3	0	0	1	0	0	0	0	0	0	0	0	***1****	***1****	1	1
SULM 4	0	0	***1****	1	0	0	0	0	0	0	1	0	0	***1****	1
SCOI 5	0	0	0	***1****	1	1	0	0	0	0	0	0	0	0	0
SOIN 6	0	0	0	1	0	1	0	0	0	0	***1****	0	0	0	***1****
SAOR 7	0	0	0	0	0	0	1	0	0	1	***1****	0	0	0	0
TLLE 8	0	0	***1****	0	0	0	0	1	0	0	0	0	0	***1****	1
TIPR 9	0	0	0	0	0	0	0	1	1	0	0	0	0	0	***1****
TTED 10	0	0	0	***1****	0	0	0	0	0	1	1	0	0	0	0
TUPS 11	0	0	0	1	0	0	0	0	0	0	1	0	0	0	***1****
OESD 12	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
OLLS 13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
OPPS 14	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
OLLC 15	0	0	1	0	0	0	0	0	0	0	0	***1****	***1****	1	1

Note: 1* entries are included to icorporate transitivity

Source: Author

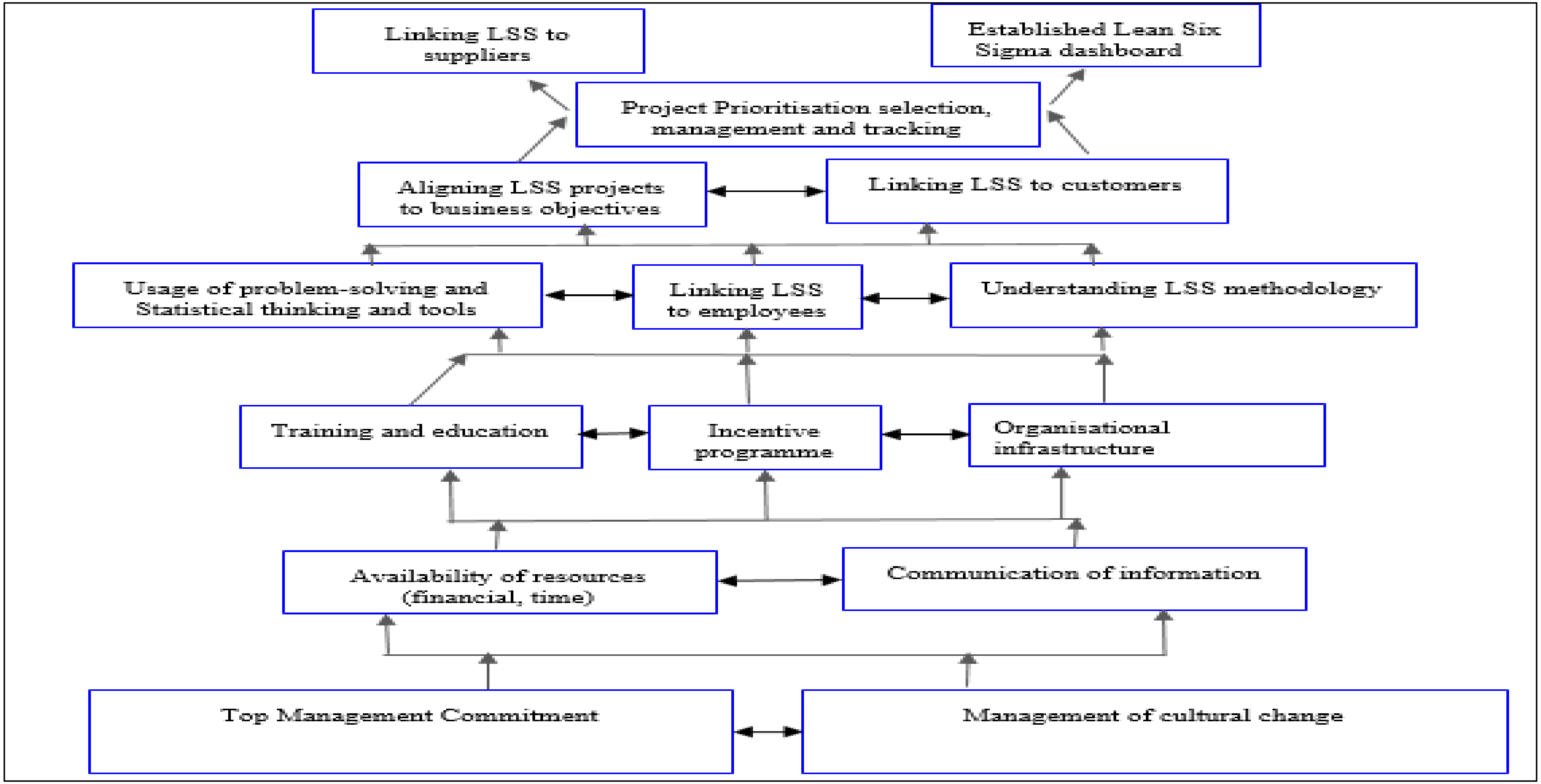


Figure 7.3: LSS deployment framework for healthcare (LSSDFH)
Source: Author

7.3 Discussion and LSSDFH operationalisation

The framework in Figure 7.3 illustrates a roadmap to deploy LSS in UAE hospitals. The starting point is at the top management commitment that is considered a significant initiating driver and enabler for the LSS process. This has to be coupled with an influential culture for management of change and acceptance towards continuous improvement. These two factors came at the base of the ISM hierarchy. Hence, these two factors support the availability of resources while fostering LSS organisational communication at level 2 of the ISM framework. Further, at the next level, availability of resources and organisational communication supports training and education, provides an incentive to employees to become part of LSS projects while establishing suitable organisational infrastructure for cross-functional teams to implement LSS. These 3 factors enable linking LSS to employees, the use of problem-solving tools and understand LSS methodology. At the next level, the aligning of LSS project to business objectives while linking it to customers lead to better project selection, prioritisation and tracking. At the next level, LSS projects lead to established LSS dashboards and linkage of LSS to suppliers. These results were somewhat similar to the works of (Kumar et al. 2016; Talib, Rahman and Quereshi 2011; Soti et al. 2010). However, the results differed from the framework suggested by Alidrisi (2014) in which the initial drivers were education and training and understanding tools and techniques within Six Sigma. It is worth highlighting that the above studies were conducted in different sectors and geographies. According to the author's knowledge, there was no similar framework identified in the literature for the UAE healthcare. This is a significant contribution to the theory of LSS in developing countries.

By splitting the framework into three levels (Shown in Figure 7.4), another contribution is presented where 'Top Management Commitment', 'Management of cultural change', 'Communication of information' and Availability of resources (financial, time) become strategic factors; 'Linking LSS to employees', 'Incentive programme', 'Training and education', 'Usage of problem-solving and Statistical thinking and tools', 'organizational infrastructure' and 'Understanding LSS methodology', are tactical factors; 'Established Lean Six Sigma dashboard' , 'Linking LSS to suppliers' ,'Project Prioritisation selection, management, and tracking', 'Linking LSS to customers' and 'Aligning LSS projects to business objectives’are operational factors. The initial clustering of CSFs (Section 3.4) into the STO themes is updated, as shown in Table 7.4.

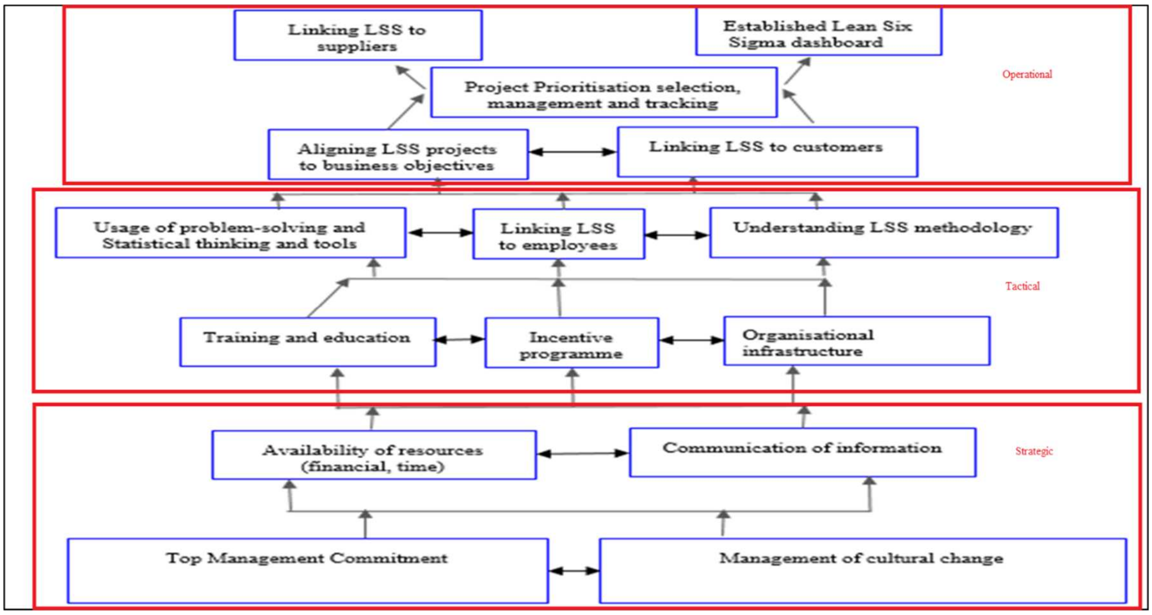


Figure 7.4: ISM split into STO clusters
Source: Author

Table 7.4: Modified clustering of CSFs

Categories (Theme)	Original clustering of CSFs	Updated Clustering of CSFs
Strategic	Top Management Commitment	Top Management Commitment
	Management of cultural change	Management of cultural change
	Aligning LSS projects to business objectives	
	Understanding LSS methodology	Understanding LSS methodology
	Communication of information	Communication of information
	Organisational infrastructure	
	Availability of resources (financial, time)	Availability of resources (financial, time)
Tactical	Linking LSS to employees	Linking LSS to employees
	Incentive programme	Incentive programme
	Training and education	Training and education
	Usage of problem-solving and Statistical thinking and tools	Usage of problem-solving and Statistical thinking and tools
		Organisational infrastructure
Operational	Established Lean Six Sigma dashboard	Established Lean Six Sigma dashboard
	Linking LSS to suppliers	Linking LSS to suppliers
	Project Prioritisation selection, management, and tracking	Project Prioritisation selection, management, and tracking
	Linking LSS to customers	Linking LSS to customers
		Aligning LSS projects to business objectives

Source: Author

7.4 Summary

This chapter makes a contribution to the LSS body of knowledge by developing a framework (LSSDFH) to understand the relationships and interdependencies between the 15 LSS CSFs identified in chapter 2 via rigorous review of the literature. The contribution stems from the fact that this is the first LSS framework in the UAE healthcare sector. Hence, this framework is an attempt to address one of the research gaps, which is the absence of a framework for LSS deployment in UAE healthcare.

Another contribution would be a new proposed path model based on the STO CSFs modelling suggested in Table 7.4. This model could be empirically tested in future studies.

Moreover, the LSSDFH has the potential to make a significant contribution to practitioners as it provides a guideline on the factors that should be in place to aid the launch, deployment and sustainability of the LSS initiative. Eventually, applying this framework is intended to increase the chances of successful LSS deployment in UAE hospitals while following some order during the implementation. However, it does have some limitations that will be discussed in the next chapter.

Based on the three data sources explored and their outcomes, the next chapter will present contributions, limitations, managerial implications and future research recommendations.

CHAPTER 8: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

8.1 Introduction

The process through which the thesis was developed is described in 8 chapters that attempted to address the 4 research objectives. The following sections present the discussion of key findings, conclusions and implication of the study. The contribution, limitations and recommendations of the study for future research are also presented towards the end of the chapter.

This study investigated the extent of LSS implementation, CSFs, challenges in UAE hospitals and further assessed the impact of LSS on hospital performance focusing on the sequencing of CSFs in a safety-critical environment where staff turnover is rife, and the multi-cultural environment presents various challenges that can impede LSS implementation.

8.2 Discussion of the key findings from empirical research

The primary aim of this study was to examine whether LSS Strategic, Tactical and Operational (STO) CSFs are positively correlated with LSS successful implementation in UAE hospitals as measured by hospital performance. Hence, the research attempted to analyse the following research question:

> *To what extent are the STO CSFs positively correlated with LSS successful implementation in UAE hospitals measured by hospital performance?*

This question may not be easy to answer. While the study results showed that there is a correlation between LSS implementation and hospital performance, it is not a simple relationship given the UAE hospitals specific nature such as the transient multicultural environment and workforce diversity. This causes staff lack of commitment and poor understanding of CI initiatives. The following sections present discussions and key contributions derived from the data analysed in Chapter 5-7 using the three different sources: surveys, interviews and the brainstorming session. The findings were compared against the literature and further mapped against the study four objectives themes below.

8.3 The extent to which LSS is implemented in UAE hospitals (OBJ1)

8.3.1 Lean is more dominant than Six Sigma

The survey results in section 5.17 showed that more than two-thirds of UAE hospitals implement some form of CI, including Lean, Six Sigma or LSS. This clearly shows the positive commitment of UAE hospitals towards implementation of Lean and Six Sigma, as they seem to realise the value of these initiatives on their operations as argued by many previous researchers who showed that LSS has an impact on hospitals operations (Khaidir et al. 2013; Elkin 2008; Antony et al. 2018). The study also revealed that Lean seems to be more dominant in UAE hospitals than Six Sigma and LSS integration is still in its early stages. This would suggest agreement with Henrique and Godinho Filho (2018) systematic review of 118 empirical healthcare papers that found that Lean is predominant among Six Sigma in 63% of the papers. This study interviews indicated that Lean was implemented before Six Sigma in UAE hospitals given its simplicity, the easiness through which it can be ‘sold’ to staff and the quick wins. Similarly, previous studies such as Kumar’s (2010) conducted in the UK SMEs found that Lean was implemented before Six Sigma. This suggested that hospitals and SMEs in various sectors could share a similar LSS deployment sequence (Lean first, Six Sigma second) as staff find deploying Lean easier regardless of the context. This is a valuable deployment contribution for practitioners.

8.3.2 Survey respondents exaggerated the extent of LSS implementation

Despite the fact that some hospitals reported full LSS implementation in the survey, interviews revealed that the said hospitals’ experience in implementing LSS is still lagging showing contradictory results. The survey respondents were claiming fuller implementation; in contrast, the interviewees reported the hospitals were just starting their LSS journey and few hospitals were implementing the full DMAIC structure while others were solely implementing the precursor of DMAIC, namely FOCUS-PDCA. What this could imply is that studies that relied on surveys have in all likelihood exaggerated the extent of LSS implementation as described by the ‘Pink factory’ concept (Baxter and Hirschhauser 2004). Hence, if researchers want a more accurate impression of the extent of implementation, they should use multiple methods in their studies. This study also showed that LSS implementation was limited as it was not treated as a strategic initiative sustained beyond projects that were completed for certification purposes. These conclusions were in consensus with previous work that argued that many organisations had limited LSS deployment (Albliwi et al. 2017; Sreedharan and Raju 2016; Aljabr 2015).

8.4 LSS CSFs, ranking and challenges in UAE hospitals (OBJ2)

8.4.1 Additional LSS CSFs are needed in UAE hospitals

Previous studies showed that there are similar global LSS CSFs that apply in different sectors and countries (e.g. top management commitment, availability of resources, training and education) (Antony et al. 2018; Sreedharan et al. 2018; Waters 2016). While the study revealed that these CSFs also apply in developing countries such as the UAE, two new CSFs emerged explicitly to the UAE healthcare, namely, workforce stability and job security. Understanding how workforce commitment and motivation are affected by these factors is critical to LSS deployment.

8.4.2 Differences of CSFs ranking in UAE hospitals and other countries exist

In this study, four sources for LSS CSFs were analysed (literature review in section 2.10, survey, interviews and ISM group as shown in Table 8.1) and as a result 15 healthcare LSS CSFs were identified. The CSFs ranking was compared and using an average rank score; the study concluded that the top five CSFs for LSS in UAE hospitals are: top management commitment, training and education, linking LSS to customers, project prioritisation, selection and tracking and aligning LSS projects to business objectives. Antony et al. (2018) also cited a number of LSS CSFs based on a literature review of 68 healthcare papers in 6 continents (North America, Europe, Asia, Africa Australia and South America). The researchers identified the following top seven factors, accounting for 80 per cent of the total CSFs: understanding of Six Sigma tools and techniques, management involvement and commitment, communication, organization infrastructure and culture, training, patient focus and cultural change. One of the reasons for the CSFs ranking differences between this study and the literature could be that these studies were conducted in different geographies and industries that bring different organisational quality maturity levels, staff competence, workforce diversity and workforce cultural issues. This was even illustrated in this study when examining the mixed results for the CSFs ranking scores from the 4 sources, demonstrating slight differences in the ranking. This could be due to the fact that respondents perceived or understood these CSFs differently and hence ranked them in a different order. This finding emphasised the need for the proper understanding of LSS CSFs when attempting to deploy LSS (Sreedharan et al. 2018; Albliwi et al. 2014). One could also argue that each of the labels like ‘top management commitment’ is too generic so that people can interpret them in different ways. The CSFs need to be more precisely defined when conducting LSS studies.

Table 8.1: LSS CSFs ranking according to the study sources

	CSF ranking				
CSF	Literature	Survey	Interviews	ISM	Average rank score
Top Management Commitment	**1**	**1**	**1**	1	1.0
Training and education	2	3	2	9	4.0
Linking LSS to customers	3	10	-	3	5.3
Project prioritisation selection, management, and tracking skills	**5**	**5**	**4**	8	5.5
Aligning LSS projects to business objectives	**6**	**7**	**7**	2	5.5
Management of cultural change	8	4	6	5	5.8
Availability of resources (financial, time)	15	2	-	6	7.7
Linking LSS to employees	10	11	3	7	7.8
Understanding LSS methodology	14	8	-	4	8.7
Organisational infrastructure	4	12	-	10	8.7
Communication of information	9	9	-	12	10.0
Established Lean Six Sigma dashboard	12	13	5	11	10.3
Usage of problem-solving and Statistical thinking and tools	11	6	-	14	10.3
Linking LSS to suppliers	7	15	-	15	12.3
Incentive programme	13	14	-	13	13.3

Source: Author

8.4.3 Weak LSS leadership and expanded top management CSF definition in UAE hospitals

It is widely advocated in the literature that leadership is one of the top success factors for LSS (Laureani and Antony 2016; Laureani and Antony 2019). However, the interviews revealed that leadership in UAE hospitals could become a hindrance for LSS because of their short-term focus lack of understanding of LSS and the lack of accessibility. The study expanded the top management CSF definition for healthcare to include hospital administrators, heads of department, physicians, government bodies and regulators. This has not been adequately addressed by literature and will need to be expanded in future studies.

8.4.4 'Accreditations and certification overload' affects LSS deployment

Another issue raised by interviewees was the competing priorities when it comes to accreditation (e.g. JCI) and certification (e.g. ISO9001) programmes in UAE hospitals. While the literature would view accreditation as an enabler for CI programmes (Devkaran and O'Farrell 2015; Melo 2016), the interviews showed that too many accreditations and certification schemes could become a burden for staff. Many interviewees mentioned that in a typical UAE hospital, there could be more than 5 different certification and accreditation schemes. Managing and maintaining these schemes puts tremendous time pressure on quality practitioners, sometimes leaving them with little time to pursue CI and LSS initiatives.

8.4.5 Lack of LSS sustainability and lack of a holistic approach to deploy LSS

Previous studies showed that the lack of LSS knowledge and unclear implementation frameworks make various organisations fear that adoption of LSS might negatively impact the business, its customers and employees (Sony et al. 2018). This study survey and interviews found that the top LSS deployment challenges most commonly encountered in UAE hospitals were lack of resources, internal resistance, frequent change of management (which results in lower management support), inadequate training and coaching and competing projects. Previous researchers (Antony et al. 2018; Albliwi et al. 2014) also cited these challenges in their studies, however this study interviews revealed the following additional challenges that are rarely cited in the literature: lack of sustainability of LSS, lack of a holistic approach to deploy LSS and the lack of advertising LSS success stories. The lack of a holistic approach has been a problem of CI forever. These findings showed that LSS implementation shares many of the features of previous initiative failings. Furthermore, interviews and the narrative part of the survey noted the following barriers: projects that are too complex, Lack of ownership of project, no integrated approach to deploy, lack of awareness of the benefits of LSS, lack of understanding of statistics, not linking LSS to financial benefits, lack of communication and use of jargon, lack of data and poor data collection methods. These barriers were aligned with previous studies (Kumar 2007; Albliwi et al. 2014; Singh et al. 2019) confirming that healthcare and other sectors in other countries share similar LSS barriers and it is not context-dependent.

8.4.6 The unique composition of the UAE workforce, transient culture and lack of incentives impede LSS implementation

Results from the interviews indicated that the transient work conditions, and the composition of the population, where 88 per cent of the population are expatriates, impeded LSS deployment in UAE hospitals. Interviewees argued that the lack of job stability and security and the nature of the transient workplace (where the staff is continuously searching for more stable and better-paid jobs) make it less likely for the staff to be motivated to participate in CI projects.

This showed a clear difference in organisational characteristics between hospitals in the UAE and other countries as previous LSS CSF studies assumed the same culture and stable work conditions (Antony, Downey-Ennis, et al. 2007; Khraiat et al. 2017; Ahmed et al. 2018). Previous authors attributed limited implementation to various staff-related factors including the fear that the application of LSS might lead to increased bureaucratisation, thereby making everything statistically controlled or that LSS initiatives will reduce staff working time, involve high initial cost, hinder organisational innovation and stifle employee creativity (Aljabr 2015). This was echoed by some interviewees, but also, they added job stability and security as new motivational factors for LSS deployment in the UAE.

Moreover, interviewees reported that it was difficult to get staff to participate in LSS deployment due to lack of incentives, lack of a holistic approach to drive LSS projects and the low visibility of successful LSS projects in healthcare. Previous authors found a positive relationship between having reward and recognition and adopting the correct culture towards LSS deployment and sustainability (Snee and Hoerl 2003; Jeyaraman et al. 2010; Albliwi 2017). This needs to be considered by healthcare top management and policymakers.

Consequently, the author would argue that LSS deployment should consider a combination of organisational and personnel dimensions to succeed. For example, the diversity of staff backgrounds and education levels and job security are factors to consider when deploying LSS in multicultural environments such as the UAE. LSS should be treated as a strategic initiative linked to resources and team members' incentive plans. If top management is serious about CI, they should provide stable work conditions for employees and share success stories with financial gains highlighted to encourage motivation.

8.5 Relationship between LSS CSFs and hospitals performance (OBJ3)

In section 6.9.2, three models were tested using PLS-SEM. Model A (Figure 4.7, page 126) tested the linear relationship between all LSS Strategic, Tactical and Operational (STO) CSFs as one construct and hospital performance. Model B (Figure 4.8, page 127) tested the linear relationship between each of the LSS STO CSFs constructs and hospital performance. Model C (Figure 4.9, page 127) tested a sequential model where Strategic CSFs drive Tactical CSFs that drive Operational CSFs towards hospital performance. The following sections discuss the implications of these models.

8.5.1 There is a positive correlation between LSS and hospital performance

Previous studies argued that there is a positive relationship between LSS deployment and organisational performance in healthcare (Sabry 2014; Deng et al. 2016; DelliFraine et al. 2010; Noori 2015). This empirical study finding was in consensus with previous literature. For example, Model A confirmed a moderate positive relationship between the LSS STO CSFs and hospital performance, explaining 38.3% of the variation in hospital performance due to LSS CSFs.

However, in Model B ((Figure 4.8 page 127), the individual Strategic and Tactical CSFs themes had a positive impact on hospital performance while Operational CSFs theme relationship with Hospital performance was not supported. These results disagreed with the previous study of Salaheldin (2009), where all STO themes relationship with the performance were supported. While Model B results did not support the inclusion of the operational factors, these unexpected results should be considered with caution as the operational factors can remain critical to operationalising LSS, as shown in previous studies. Interestingly, the interviewees explained that many LSS projects were discontinued at the beginning; hence, it could be the survey respondents reported weak Operational CSFs since LSS projects did not reach the operational stage .

8.5.2 LSS deployment in UAE hospital follows a clustered CSF and sequenced model

Previous studies such as Salaheldin (2009), Sabry (2014) and Noori (2015) did not consider the sequencing of CSFs. The only study to consider CSF sequential clustering for a multi-sector was Lamine and Lakhal's (2018) research that explored the Tunisian market. A key contribution in this study is that it concluded that the sequential model (i.e. Model C) defined by the relationships between Strategic CSFs → Tactical CSFs followed by Tactical CSFs → Operational CSFs followed by Operational CSFs → Hospital performance) appeared to be the best fit with the data, and was therefore superior to Model B. This model predicted that Strategic CSFs are the enablers for the Tactical and Operational CSFs leading to elevated Hospital performance due to LSS deployment. These results showed that the three CSFs themes (Strategic, Tactical and Operational) do not work independently but rather in a sequential manner. Hence, this study proposed an original model for UAE healthcare, and this has not been discussed by other researchers. This was an interesting finding and is further confirmed by this study ISM framework results that also explained how the CSFs are interlinked.

In particular, this study has been uniquely useful in identifying and describing a number of CSF elements that make up a comprehensive approach to LSS deployment process. Figure 8.1 illustrates the proposed clustered model for LSS deployment is UAE hospitals. The following describes how the model should be operationalised. The model suggests that before any LSS programme is launched the following should be in place: top management commitment, availability of resources, linking the LSS programme to strategic objectives, strong culture for accepting change and a strong understanding of the LSS methodology and its benefits. The hospital management can then begin staff training and education, incentivising the workforce to participate, linking the programme to employees' performance appraisals and using problem-solving and statistical thinking and tools. Afterwards, projects are launched, and projects charters are drafted linking LSS to customers and suppliers. At this operational stage, projects are continuously prioritised, managed and tracked via dashboards.

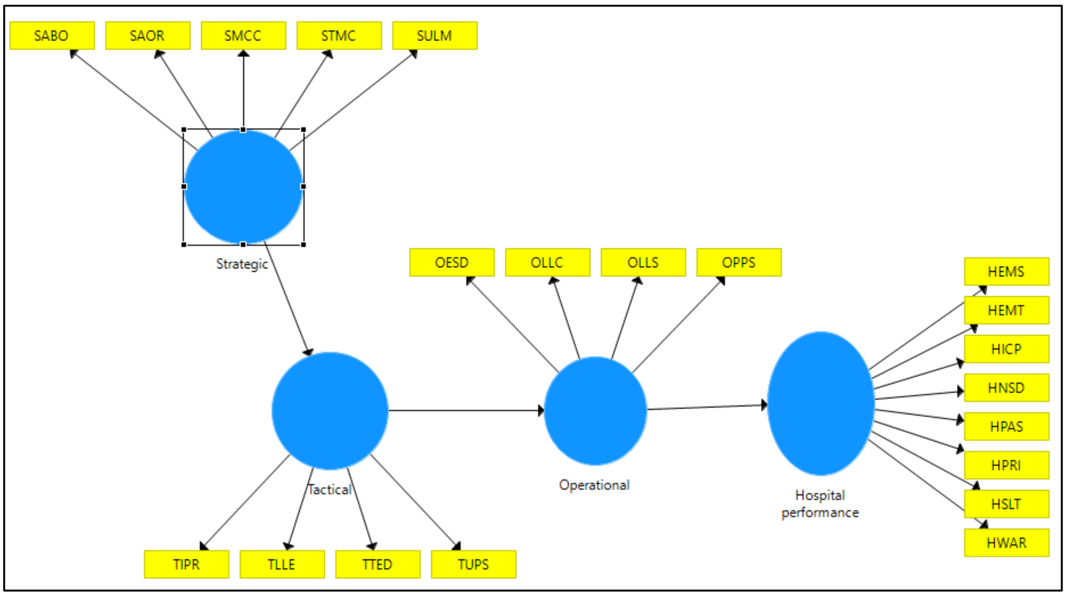


Figure 8.1: Proposed LSS deployment model
Source: Author

8.5.3 Moderators (JCI, ISO9001, hospital size and hospital type are statistically insignificant to support LSS

A moderator is a variable that would affect the relationship strength between independent variables (LSS deployment) and dependent variables (hospital performance) (Hair et al. 2017). This study proposed and tested four moderators (JCI accreditation status, hospital size (Number of beds), hospital type (Government vs private) and ISO 9001 certification status). However, they were found insignificant as per section 6.10. Previous work would suggest that accreditation and certification schemes (e.g. JCI, ISO 9001) would enhance the deployment of quality improvement initiatives such as LSS (Melo 2016; Shah et al. 2008; Abdallah 2014; Kumar 2010); however, this study has been unable to demonstrate that these moderators lead to better LSS implementation. Consequently, this study survey results could not empirically confirm that JCI accreditation supported LSS deployment and further did not concur with the study of Shah et al. (2008) that showed that ISO 9001 supported LSS deployment. The 'Accreditation and certification overload' factor discussed in section 8.4.4 could be the reason why these accreditations and certifications did not support LSS deployment. Therefore, the author argues that these study findings may require more investigation as one may propose that quality frameworks (e.g. ISO 9001) would support LSS implementation, given that ISO requirements inherently include many of the LSS CSFs (Marques et al. 2013; Kumar 2010).

8.6 Development of a Framework for LSS deployment in UAE hospitals (LSSDFH) (OBJ4)

Previous studies indicated that there is a lack of LSS deployment frameworks or readiness assessment models to guide the deployment of LSS in hospitals (Antony et al. 2018). This was also evidenced during the interviews that called for the development of healthcare-specific LSS deployment frameworks that fits the UAE. Although there were similar frameworks in other industries and other countries (Alidrisi 2014; Yadav and Desai 2017; Soti et al. 2010), there was no similar framework to deploy LSS in UAE healthcare. This study added to the existing literature by developing the LSSDFH and provided a better understanding of the 15 CSFs interdependencies in UAE hospitals that will be valuable for practitioners to better deploy LSS given the unique composition of the UAE workforce and transient culture.

The proposed framework (LSSDFH) in Figure 7.3 page 253 puts forward a road map for LSS deployment in UAE hospitals. The framework contributed to the understanding of the relationships between the CSFs explaining how these factors may work in tandem and/or could act as a prerequisite (e.g. availability of resources towards LSS initiatives requires top management commitment). Interestingly, the type of relationships will depend on a number of variables, including the culture and maturity of the quality structure in organisations. Given the subjective nature of the ISM exercise, this study ISM framework could be limited to UAE hospitals and will be difficult to compare with other frameworks objectively; however, the framework has some resemblance to Soti et al. (2010) framework which asserted that Strategic factors (enablers) strengthen Tactical enablers, while Tactical enablers support the Operational enablers. The researchers used the Matrix Impact of Cross Multiplication Applied to Classification (MICMAC) analysis to analyze the driver and dependency power of enablers revealing that ‘effective top management leadership role’, ‘availability of funds’ and ‘availability of expert training’ are strategic requirements. This study was different from Soti’s et al. study as it added management of cultural change, understanding LSS methodology and communication of information as additional CSFs to strategic enablers. Considering these CSFs in future frameworks would support LSS deployment where, for example, the understanding of LSS methodology becomes critical for any LSS initiative. With the absence of LSS deployment models in the UAE healthcare sector, this study framework could be considered an important original contribution towards the existing body of knowledge in an aim to better guide hospitals in their LSS journey.

8.7 Summary

The previous sections have critically discussed the key findings of the empirical study based on three data sources, proposing insights for the main research objectives that emerged in Chapter 1. The exploration of the current status of LSS that was raised during the survey and interview phases concluded that LSS is not implemented as an integrated approach as Lean tends to be more dominant than Six Sigma in UAE hospitals. Further, the study developed a better understanding of LSS CSFs and the impact on hospital performance where this study suggested an original model of clustering STO LSS CSFs in a sequential manner that impacts hospital performance. The study also empirically tested the impact of a number of moderators on the relationship between CSFs and hospital performance shown in section 6.10; however, the moderators' impact was not proven. The next sections will present a summary of the study contributions.

8.8 Research Contributions

In a doctoral thesis, contribution to knowledge and practice is a critical part of the outcomes (Easterby-Smith et al. 2012). Evidence showed that LSS implementation is relatively new, with limited publications in healthcare in developing countries and, hence, it was essential to extend knowledge in this area. Consequently, this study established the current status of LSS in UAE hospitals and has made a contribution to both theory and knowledge by investigating LSS implementation issues such as healthcare-related LSS CSFs, barriers and impact on performance and comparing the results with LSS literature in developed and developing countries. Moreover, this study contributed methodologically by employing a mixed-method approach within LSS research in healthcare. Table 8.2 summarises the key contributions of this study that makes it different from previous research work:

Table 8.2: Novel contributions of this study

Research Objectives	Novel Contributions*
1. To examine the extent to which LSS is implemented in UAE hospitals.	• Usage of a mixed-methods study investigating LSS deployment in UAE hospitals; hence, it could be considered as a methodological contribution. • Identified that UAE hospitals are mainly implementing Lean tools or CI cycles such as PDCA with the sporadic implementation of Six Sigma. • Interviews indicated that Lean is implemented more than Six Sigma in UAE hospitals given its simplicity, the easiness through which it can be 'sold' to staff and the quick wins that be shown to management. • Results from the interviews indicated that the transient nature of the country and diversity of the workforce have a negative impact on the LSS deployment in UAE hospitals. • Revealed that the lack of stable workforce conditions affects staff commitment towards CI initiatives. • Indicated that governmental hospitals (49.1%) tend to implement LSS more than private hospitals(41.2%) given the funding and support from the government. • Most of the LSS deployment is in Abu Dhabi and Dubai hospitals. • Indicated that 85% of the surveyed hospitals implementing LSS are large hospitals (i.e. more than 100 beds). This could indicate that large hospitals would have the resources available to deploy LSS.
2. To identify the significant LSS CSFs and allocate them to their STO themes in UAE hospitals to develop a conceptual model.	Key findings in this section were similar to literature on CSFs & barriers, except the following: • New barriers were identified: lack of sustainability of LSS, lack of a

	holistic approach to deploy LSS and the lack of advertising LSS success stories • The study identified new CSFs. These are workforce stability and job security. • Previous research had limited discussion on the role of government entities in driving LSS. This study expanded the top management CSF definition to include administrators, heads of department, physicians, government bodies and regulators.
3. To evaluate the correlations between STO CSFs and LSS successful implementation measured by UAE hospital performance.	• Confirmed that there is a positive relationship between LSS CSFs and hospital performance Proposed and tested models for clustered CSFs. (Model A). • Suggested a new clustered sequential model for LSS CSFs linked to hospital performance (Model C) • Moderators such as ISO 9001, JCI and size of the hospital are not statistically significant to support LSS deployment.
4. To develop a framework for LSS deployment in UAE hospitals clarifying the interdependencies between the CSFs	• Proposed a new LSS deployment framework (LSSDFH) based on qualitative input (e.g. ISM) explaining how CSFs are interlinked, operationalising deployment of LSS in hospitals.

*Compared the research findings against previous studies (Alosani and Yusof 2018; Lamine and Lakhal 2018; Carmona-Márquez et al. 2016; Sabry 2014; Noori 2015; Albliwi et al. 2014; Soti et al. 2010; Antony et al. 2018; Sreedharan et al. 2018; Salaheldin 2009)

8.9 Practical contributions

A study should make a contribution by affecting practices. These conclusions can support policymakers, practitioners to modify their practices and even mindsets. These contributions can come in the form of suggestions, guidelines, road maps, frameworks or models. In practice, the findings of this study have important implications for the UAE hospitals and for the healthcare sector at large in other countries in GCC and the Middle

East in general. As LSS implementation is still at its early stages in UAE hospitals, these valuable findings can improve LSS implementation efforts, avoid pitfalls and lead to better results. The practical contributions presented are as follows:

- A better understanding of the positive relationship between LSS implementation and hospital performance through the exploration of the CSFs and barriers prior to the launch and during the implementation of LSS programmes.
- Development of an ISM-based framework that can provide hospital management and quality practitioners a more realistic roadmap during the course of implementing LSS by understanding the contextual relationship among LSS CSFs through a single systematic framework. The advantage of the proposed framework lies in imposing order and direction on the complexity of relationships among these factors, which would help the management and quality practitioners to utilise their available resources for better LSS deployment.
- The ISM framework can be adopted as a readiness assessment tool.
- The PLS-SEM tested CSF clustered, and sequenced model provides better insight into the various STO CSFs required to launch, implement and sustain LSS in hospitals.
- Lean can be used as an 'eye-opener' for CI in hospitals prior to Six Sigma so quick wins can be achieved, and staff can buy into the improvement initiatives.
- At the outset of LSS programme launch in a hospital, it is recommended to create LSS awareness through a series of communication sessions to explain how LSS relates to healthcare and its benefits as many still view Six Sigma as an approach that is only limited to manufacturing.
- Government entities and private healthcare investors should view LSS as a holistic strategic management approach for improvement. The initiative should be managed and driven by a central unit (e.g. quality council) with top management as members to ensure LSS programmes are smoothly launched and sustained. Moreover, LSS projects could be viewed as a vehicle for improvement that may be considered in every hospital area.
- Practitioners should utilise proven change management approach (e.g. Kotter 8 steps) to overcome resistance and ensure change is driven in the correct sequence.

8.10 Limitations of the study

Like many other quantitative studies utilising online survey questionnaires, limitations include sample size, the interpretation of the results, as well as their generalisability (Sedgwick 2013; Barrett and Schriger 2015; Omair 2014). A strength of the present study was the use of a mixed-methods approach including surveys, semi-structured interviews and group brainstorming session in an effort to overcome some of the common research limitations that may significantly affect contributions. The following were some of the limitations:

- The data collected in this study were from one GCC country within the Middle East and from one sector, in this case, the healthcare sector. The sample was composed of respondents from the quality department in UAE hospitals. Hence, the results may not be generalised.
- The potential for self-reporting bias may exist as a result of using a survey that measured the perception of the respondents. This is a common issue when collecting perception data from organisations' staff, however measuring staff perception has been widely used and accepted by researchers in quality and LSS studies (Albliwi et al. 2017; Monteiro de Carvalho et al. 2014; Lamine and Lakhal 2018; Antony et al. 2019).
- Hospital performance was measured using subjective measures based on hospital quality and LSS practitioners perception on how their hospital performed as a result of LSS implementation.
- Another issue is that primary data have been collected from an online survey, and therefore, no deeper insights could have been captured from the survey.
- There is no practical way whereby a researcher can ensure the truthfulness and sincerity of the respondents when completing a survey questionnaire.
- Certain limitations arise when conducting interviews, including interviewer bias and not using appropriate interviewing methods (Saunders et al. 2009).
- The study was based on a cross-sectional data collection where data are collected at a single point in time, rather than a longitudinal study hence findings must be considered with caution in drawing any conclusions about changes over time.
- The proposed LSS framework (LSSDFH) was not validated statistically or in a real-life project to assess how it will perform and its impact on LSS projects.

8.11 Recommendation and propositions for future research

While the study has revealed that the interest in LSS is growing in the UAE, its application in UAE healthcare was still at its infancy. The previous discussion on limitations presents some opportunities to test future propositions to overcome generalisability and other issues. Based on this study findings and literature, the following opportunities and propositions are put forward for future research.

There is an opportunity to expand the scope of LSS research in the Middle East and developing countries. This will provide better insights into LSS deployment comparing the results to other studies in the other countries and sectors. Other factors can emerge due to cultural differences, as discussed in section 8.4.1. Moreover, the ranking of these CSFs may differ from one country and sector to another as per section 8.4.2. Hence, the study can be considered as a base to conduct comparative studies in other sectors in the UAE and other countries. Propositions that could be tested based on the aforementioned paragraph is:

> **Proposition 1**: The LSS CSF clustered model validated in this study is valid for other sectors and countries (This Thesis: Section 8.5.2 and Figure 8.1).
>
> **Proposition 2:** CSFs differ in importance (i.e.ranking) between the healthcare sector and other sectors in the UAE (This Thesis: Section 8.4.2)

This study considered a survey and interviews to collect data about LSS deployment at one time. Further research could be undertaken to investigate the impact of LSS on UAE hospitals over time by conducting a longitudinal study and by collecting primary data on hospitals' performance provided accessibility to data is granted. The aforementioned statement leads to the following proposition:

> **Proposition 3:** Success of LSS deployment is affected by the duration of the deployment.

This study has generated an LSS framework for deployment (Figure 7.4) through the ISM exercise. Further work could be done to validate the proposed framework (e.g. using SEM) statistically. This could be compared with other similar frameworks in other sectors to explore similarities and differences. Following proposition is deduced from the aforementioned statement:

Proposition 4: The ISM LSS deployment framework is valid statistically and is similar to other sectors (This Thesis: Section 7.2).

The study has revealed that workforce stability and transient culture in the UAE affects LSS deployment. Future research could be conducted to understand the specific effect of transient culture and job dynamics on LSS implementation in developing countries. The above argument leads to the following proposition:

Proposition 5: LSS implementation is affected by the type of country culture, workforce composition and the extent of workforce diversity (This thesis: Section 8.4.1)

More research could be conducted on the supporting CI tools used during LSS implementation. The study reported that some UAE hospitals are using some CI tools, but many struggles with their understanding and proper application that could affect LSS deployment as shown in previous studies (Ismyrlis and Moschidis 2013; Antony et al. 2018). The above argument leads to the following proposition:

Proposition 6: There exists a causal relationship between LSS deployment and effective usage of tools (This thesis: Section 2.8.1)

The study did not focus on LSS deployment and employee morale and motivation. Future studies could explore the link between poor LSS implementation and its negative impact on employee morale, satisfaction and innovation (Antony et al. 2019; Sony et al. 2018). The above argument leads to the following proposition:

Proposition 7: There exists a relationship between LSS deployment and employees morale and satisfaction. (This thesis: Section 8.4.5)

Finally, this kind of study could be extended to private and public sectors in developing and developed countries to provide more conclusive and broader answers on the benefits of LSS. The methodology used in this study may be replicated to provide comparative data with regards to the results of the relationships between LSS CSFs and organisational performance in the healthcare sector and other sectors. A natural expansion of this study would be to carry out similar studies in UAE manufacturing and service organisations.

These propositions are not intended to be an exhaustive list, but indications for further exploration that have emerged from this study and is reportedly under-researched in the literature review.

8.12 Implications for practitioners and policymakers

The previous chapters had their own summaries and conclusions. The following implications are basically summaries of those sections, made to facilitate LSS deployment at UAE hospitals:

- Active and visible top management support has emerged as the most crucial factor to facilitate LSS deployment in UAE hospitals. Hence, top management should accept its responsibility to provide continuous support to LSS initiatives in an attempt to improve organisational performance. Moreover, top management should lead and actively participate in LSS programmes if they want to realise a positive impact on their hospital performance. Their visible support should be translated into allocating resources including time, people and budgets to support continuous training and education to staff.
- LSS measurement and reward systems need to become an integral part of the performance management system. Employees should be provided with incentives for their participation in LSS projects.
- LSS should be viewed as an intervention that can reduce cost while improving the quality of services or products, leading to better customer satisfaction. Hence, UAE hospitals need to create a culture that fosters change and builds on the values of cross-functional teamwork and improvement. This will help link LSS to employees creating involvement to support LSS projects.
- Training and continuous education is a cornerstone for LSS success. Aiming to create a working understanding of the descriptive and inferential statistics (Antony et al. 2019) training becomes a critical issue which should never be underestimated as management need to support LSS education plans.

- LSS projects success stories should be published. LSS storyboards may be shared while celebrating the achievement and rewarding the team members. This may be done via organizational-wide forums attended by top management.
- Many patients are expecting hospitals to uplift their services just like any hospitality business providing services that can ‘WOW’ and exceed their expectations. One approach that may be helpful during LSS implementation is to utilise innovation as alluded by other researchers. (Polk 2011; Antony et al. 2016; Salah 2017). The integration of innovation with LSS to improve the delivery of hospitals services emerged as an improvement opportunity in previous studies (Antony et al. 2019) and was raised during this study interviews. However, other researchers argued that Six Sigma might stifle employees’ creativity and innovation as it limits their thinking by using the structured DMAIC approach (Hindow and Grow 2007; Sony et al. 2018).

8.13 Conclusion

This study provided a more in-depth insight into LSS CSFs in UAE hospitals. Broadly speaking, the survey, interviews and brainstorming session showed that LSS implementation in the UAE hospitals is still in its early stages. Although there are some attempts to implement an integrated LSS approach, the implementation remained focused on some CI tools and Lean practices.

The empirical analysis confirmed that LSS has a positive impact on hospital performance affirming previous research; however, the study empirically tested and presented a new sequential model for deployment. Moreover, the thesis developed a deployment framework for quality and LSS professionals based on the ISM approach. The study also confirmed that the success of LSS projects in hospitals depends on a number of factors including top management visible commitment and buy-in, management of change, availability of resources, education and training, and linking LSS to employees. While the UAE healthcare LSS CSFs were found to be similar to global ones, new CFSs were added.

Although there were some reported success stories claiming to have successfully applied the formal DMAIC structured approach, findings also suggested that LSS has not been fully implemented in a holistic manner in UAE hospitals, It is noted that there were many

UAE hospitals that implemented FOCUS-PDCA and Lean principles/ tools as they found them easier to implement given Lean simplicity compared to perceived ‘advanced statistical’ Six Sigma. Moreover, feedback illustrated that it is easier to involve staff in Lean events, given the quick and tangible results. This seems in agreement with other research findings on LSS application in healthcare where Lean seems to be more dominant than Six Sigma.

Finally, LSS could support organisations become successful and competitive if viewed as a strategic management approach towards improvement. It is also noted that healthcare has a specific nature given the complexity of its processes and the departmentalised and hierarchical organisational structure. Therefore, to successfully implement LSS in healthcare, a deeper understanding of the specific nature of this sector, is required. Moreover, LSS programmes should be supported by a set of factors to ensure its launch, implementation and sustainability. With these results, an opportunity arises to further develop LSS research and practices in the UAE healthcare sector and other sectors.

8.14 Personal reflections

The last 4 years presented an excellent opportunity for the author to explore LSS from a new angle. In his 29-year career as an engineer, quality auditor, quality manager, consultant and LSS practitioner, the author had the privilege to work with hundreds of organisations in different sectors and in many countries. Since the introduction of Lean and Six Sigma, many organisations have attempted to implement various improvement methodologies. Some have succeeded, and some have failed. However, many questions emerged during LSS deployment. Among these questions were: ‘Does quality work? Does LSS impact organizational performance?’ Most of the times, these questions were answered by an affirmative nod or by a simple no. The author felt that respondents were shooting from the hip and answers were not based on evidence.

This prompted the author to take on this research and to put on his academic hat seeking knowledge hence challenging his own current convections. Moreover, the author found this study an excellent opportunity to explore some of these questions from a different vantage point. This required a transformation in his own thinking hence becoming more critical and questioning every source, written or verbal and highlighting strengths and weaknesses in any presented argument.

The doctorate undertaking was also full of challenges. A ‘juggling’ act as the author described to his participants while delivering training and coaching sessions. The author described himself as a juggler with 3 balls: Family, work and the doctorate research. This experience has sharpened the author organizational and time management skills while pushing the envelope on many fronts. Moreover, the author was challenged at the beginning of the research to transform his mindset from a consultant to an academic and hence, alter his reading and writing process. Both the taught modules and research components supported the author to develop his research capabilities. In addition to the research skills gained, the author had the opportunity to connect and meet a number of scholars through various academic networks and forums. This was another highlight of the author’s enriching doctoral journey.

While the author continues his career as a management consultant and LSS practitioner and coach, he will blend the findings from his academic endeavour with his practical experience in an effort to better help organisations achieve better results. The author aims to continue his academic journey by publishing a number of papers or a book and start teaching classes at universities.

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APPENDIX A: CSFs Listing by Researchers

Researcher(s)	Identified CSFs	Sector
(Spanyi & Wurtzel 2003)	1. Visible management commitment; 2. Clear definition of customer requirements; 3. Shared understanding of core business processes and their critical characteristics; 4. Rewarding and recognising the team members; 5. Communicating the success and failure stories; 6. Selecting the right people and the right projects.	small and medium enterprises (SMEs) environment
(Achanga et al. 2006)	1. Leadership and management; 2. Finance; 3. Skills and expertise; and 4. Culture of the recipient organisation.	Lean Manufacturing within SMEs
(Banuelas Coronado & Antony 2002a; Antony & Banuelas 2002b)	1. Management commitment and involvement; 2. Understanding of Six Sigma methodology, tools and techniques; 3. Linking Six Sigma to business strategy; 4. Linking Six Sigma to customers; 5. Project selection, reviews and tracking; 6. Organizational infrastructure; 7. Cultural change; 8. Project management skills; 9. Linking Six Sigma to suppliers; 10. Training; and 11. Linking Six Sigma to employees (human resources).	UK private and public organisations
(Fryer et al. 2007)	1. Management commitment 2. Customer management. 3. Supplier management 4. Quality data, measurement and reporting 5. Teamwork 6. Communication. 7. Process management. 8. Ongoing evaluation, monitoring and assessment 9. Training and learning 10. Employee empowerment. 11. Having aims and objectives that are communicated to the workforce and used to prioritise individual's actions – a corporate quality culture. 12. Product design 13. Organisational structure.	SMEs-based on Literature review on 29 papers
(Tyagi et al. 2016)	1. Management commitment, involvement and partic 2. Uses of innovative techniques 3. Understanding of Six Sigma tools and techniques 4. Understanding of Six Sigma methodology 5. Suppliers involvement 6. Strategic vision 7. Specialized team for Six Sigma 8. Regular audits	Indian Auto Sector

	9. Project prioritisation and selection 10. Project planning and management 11. Project management skills 12. Process documentation 13. Organizational infrastructure 14. Make proper investment in resources 15. Linking Six Sigma to suppliers 16. Linking Six Sigma to employees 17. Linking Six Sigma to customers 18. Linking Six Sigma to business strategy 19. Leadership 20. Knowledge Sharing 21. Integrating Six Sigma with the financial infrastruct 22. Incentive program 23. Fact-based decision making 24. Employee's commitment 25. Education and training 26. Customers satisfaction 27. Customers involvement 28. Cultural change 29. Communication 30. Clear performance metrics	
(Laureani & Antony 2012a)	1. Management commitment 2. Organizational culture 3. Linking LSS to business strategy 4. Leadership styles 5. Communication 6. Linking LSS to customers 7. Awareness 8. Selection of LSS staff 9. Data based approach 10. LSS projects selection/prioritisation 11. LSS projects tracking and review 12. Resources for LSS staff 13. LSS training 14. LSS tools and techniques 15. Project management skills 16. LSS financial accountability 17. Organization infrastructure 18. Extending LSS to supply chain 19. Linking LSS to HR	Manufacturing and service industry
(Jeyaraman & Teo 2010)	1. Management engagement and commitment 2. Reward and recognition system 3. Organizational belief and culture 4. Frequent communication and assessment on Lean Six Sigma result	electronic manufacturing services

	9. Project prioritisation and selection 10. Project planning and management 11. Project management skills 12. Process documentation 13. Organizational infrastructure 14. Make proper investment in resources 15. Linking Six Sigma to suppliers 16. Linking Six Sigma to employees 17. Linking Six Sigma to customers 18. Linking Six Sigma to business strategy 19. Leadership 20. Knowledge Sharing 21. Integrating Six Sigma with the financial infrastruc 22. Incentive program 23. Fact-based decision making 24. Employee's commitment 25. Education and training 26. Customers satisfaction 27. Customers involvement 28. Cultural change 29. Communication 30. Clear performance metrics	
(Laureani & Antony 2012a)	1. Management commitment 2. Organizational culture 3. Linking LSS to business strategy 4. Leadership styles 5. Communication 6. Linking LSS to customers 7. Awareness 8. Selection of LSS staff 9. Data based approach 10. LSS projects selection/prioritisation 11. LSS projects tracking and review 12. Resources for LSS staff 13. LSS training 14. LSS tools and techniques 15. Project management skills 16. LSS financial accountability 17. Organization infrastructure 18. Extending LSS to supply chain 19. Linking LSS to HR	Manufacturing and service industry
(Jeyaraman & Teo 2010)	1. Management engagement and commitment 2. Reward and recognition system 3. Organizational belief and culture 4. Frequent communication and assessment on Lean Six Sigma result	electronic manufacturing services

	5. Project prioritisation, selection, reviews and tracking 6. Effective Lean Six Sigma training program 7. Project success stories and best practices sharing 8. Company financial capability 9. Established Lean Six Sigma dashboard 10. Competency of Master Black Belt and Black Belt 11. Financial results measures 12. Linking Lean Six Sigma to business strategy 13. Monitoring and evaluation of performance measurements 14. Promotional path for greenbelts and Black Belts 15. Sufficient time to solve problems 16. Lean Six Sigma organizational structure 17. Linking Lean Six Sigma to suppliers 18. Organizational infrastructure 19. Shared understanding of core business processes and their critical characteristic 20. Linking Lean Six Sigma to customers 21. Understanding of Lean Six Sigma methodology, tools and techniques 22. Greenbelt and blackbelt selection process developed 23. Operational excellence department visibility to execute LSS program 24. Top management knowledge of the key processes 25. Project management (including project champion and teamwork and composition)	
(Anbari & Kwak 2004)	1. Management commitment 2. Organisational involvement 3. Project governance 4. Project selection 5. Planning 6. Implementation methodology 7. project management and control 8. Cultural change 9. Continuous training	
(Chakrabarty et al. 2007)	1. Top management commitment, 2. Education and training 3. Cultural change 4. Customer focus 5. Clear performance metrics 6. Attaching success to financial benefits 7. Organisational understanding of work processes	Service industries
(Henderson & Evans 2000)	1. Upper management support 2. Organisational infrastructure 3. Training 4. Application of statistical tools 5. Link to human resources-based actions (e.g., Bonuses, promotions, etc.)	
(Desai et al. 2012)	1. Management involvement and participation 2. Organisational infrastructure 3. Linking Six Sigma to customers 4. Linking Six Sigma to business strategy	Indian Industries

	5. Training 6. Linking Six Sigma to employees 7. Leadership for Six Sigma 8. Understanding of Six Sigma methodology 9. Project prioritisation and selection 10. Project management skills 11. Cultural change 12. Linking Six Sigma to suppliers	
(Hilton et al. 2008; Sabry 2014)	1. Executive commitment 2. Adopting the philosophy 3. Benchmarking 4. Training 5. Closer customer relationships 6. Closer supplier relationships 7. Open organisation 8. Employee empowerment 9. Flexible operations 10. Process improvement 11. Measurement 12. Organisational structures 13. Zero defects mentality 14. Teams 15. Planning and values 16. Audits 17. Problem-solving tools 18. Design and engineering 19. Production	Hospital
(Alsmadi et al. 2012)	1. Linking Six Sigma to business strategy 2. Linking Six Sigma to Customers 3. Project Management skills 4. Executive leadership and senior management support 5. Organizational infrastructure and readiness 6. Management of cultural change 7. Project selection and prioritisation 8. Integration of Six Sigma with Financial metrics 9. Understanding Six Sigma methodology 10. Training and education 11. Project tracking and reviews 12. Incentive programs 13. Company-wide commitment 14. Linking Six Sigma to Suppliers 15. Linking Six Sigma to employees	Fortune 100 companies in Saudi Arabia
(Soti et al. 2010)	1. Effective top management leadership role 2. Quality maturity level of the organisation. 3. Availability of funds 4. Organizational infrastructure 5. Availability of expertise training 6. Statistical thinking. 7. Employees' adaptability and flexibility towards learning	Indian Industries

	8. Committed workforce. 9. Reliable data gathering and retrieval system. 10. Technical competence 11. Organizational culture	
(Lande et al. 2016)	1. Training (employee involvement) 2. Management involvement and Commitment 3. Customer satisfaction 4. Leadership 5. Project prioritisation and selection 6. Cultural change 7. Understand LSS methodology 8. Strategic quality planning 9. Process management 10. Product design 11. Linking LSS to customers 12. Linking LSS to business strategy 13. Employee satisfaction 14. Employee reward 15. Inventory control 16. Communication of information 17. Linking LSS to employees 18. Linking LSS to suppliers 19. Employee relation/empowerment 20. Quality measurement system/quality data 21. Benchmarking 22. Role of quality department	Indian SMEs
(Manville et al. 2012)	1. Senior management commitment, support and enthusiasm 2. Linking LSS to business strategy; 3. Linking LSS to the customer; 4. Understanding the tools and techniques; 5. Project selection and prioritisation; and 6. Training and education.	Middle Management
(Brun 2011)	1. Management involvement and commitment 2. Cultural change 3. Communication 4. Organizational infrastructure and culture 5. Education and training 6. Linking SS to business strategy 7. Linking SS to customer 8. Linking SS to human resources 9. Linking SS to suppliers 10. Understanding tools and techniques within SS 11. Project management skills 12. Project prioritisation and selection	Based on 18 studies

(Deng et al. 2016)	1. Motivation to adopt Six Sigma 2. Top management support and commitment 3. Culture of the organisation 4. Other quality initiatives and their maturity 5. Resources imputed 6. Information system and organisational infrastructure employee engagement 7. Team leader experience 8. Communication 9. Training 10. Promotion 11. Standardization 12. Projects deployed under structured improvement procedure 13. Alignment Six Sigma projects' goals with strategic goals 14. Implementation Six Sigma focus on metrics	Based on 34 papers in different sectors and areas
(Øvretveit & Aslaksen 1999)	1. Management and physician involvement at all levels 2. Good data systems 3. The right training 4. Effective project team management	six Norwegian hospitals for quality improvemen t
(Antony & Kumar 2012)	1. Senior management commitment and involvement 2. Focusing on critical processes for improvement 3. Establishing a culture of continuous improvement 4. Focusing on the needs of patients 5. Establishing measurement and feedback systems	Hospitals in Scotland
(Waters 2016)	1. Leadership and management commitment and support 2. Organizational cultural change 3. Six Sigma Training 4. Aligning SS projects to business objectives 5. Linking Six Sigma to Customers 6. Project Selection 7. Organizational Infrastructure 8. Understanding the DMAIC method, tools, techniques, and key metrics 9. Accountability - tying results to financial terms or bottom line 10. Project management skills and iterating PDSA loops 11. Strong communication plan or effective communication 12. Selection of team members and teamwork 13. Selecting the best process 14. Linking to suppliers and HR 15. Clear performance metrics or a measurement assurance system 16. Employee involvement 17. Project tracking and reporting capabilities	Healthcare

	18. Supportive IT systems 19. Company-wide commitment 20. Organization-wide deployment and awareness 21. Availability of resources (financial, time) 22. Established clear roles and responsibilities 23. Control phase monitoring to maintain results 24. Accountability and Recognition 25. Incentive Program	
(Sambhe & Dalu 2011)	1. Top management leadership and commitments. 2. Team selection for Six Sigma project. 3. A well-developed strategic planning system. 4. Employee training and education on Six Sigma methodology and utilisation of quality tools. 5. Effective communication on Six Sigma programme. 6. Project prioritisation and selection. 7. Linking Six Sigma to business strategy. 8. Organisational infrastructure. 9. A well-implemented customer management system. 10. Culture of collaboration and cooperation. 11. Project management skills. 12. Empowerment and authority at all levels. 13. Linking Six Sigma to suppliers. 14. Linking Six Sigma to business strategy. 15. Role of information technology.	Indian Automotive
(Ho et al. 2008)	1. Incentive/reward system. 2. Investment of essential resources. 3. Business strategy based on customer demands. 4. The use of data analysis with data that is easily obtainable. 5. Top management's commitment and participation.	Green belts participants in Taiwan
(Antony et al. 2018)	1. Understanding of Six Sigma tools and techniques 2. Management involvement and commitment 3. Communication 4. Organisation infrastructure and culture 5. Training 6. Patient focus 7. Cultural change 8. Goal-based approach 9. Employee engagement 10. Clear performance metrics 11. Effective leadership 12. Project management skills 13. Linking Six Sigma to business strategy 14. Project prioritisation and selection 15. Financial return 16. Organisational readiness	Healthcare

APPENDIX B: CSFs Descriptions

CSF	Description	Sources
Top management commitment	Leadership and visible top management support, involvement and commitment have been reported as the top critical element for the success of Six Sigma and Lean in many industries and in different countries and various organisational sizes. In a Six Sigma organisation, top management should understand, participate and support LSS projects by allocating budget and resources. Since Six Sigma is considered a top-bottom methodology, the top of the upside down pyramid must be firmly grounded in the values and behaviours of the organisation's executive leadership.	(Albliwi et al. 2014; Antony and Banuelas 2002; Laureani and Antony 2016; Laureani and Antony 2017; Pande 2007; Desai et al. 2012; Harry and Schroeder 2000)
Training and education	Training is one of the core elements in organisations to initiate change. Quality improvement initiatives such as LSS mandate that staff is trained and educated on the methodology and tools. To allow the successful execution of LSS, training programs and education on LSS should be conducted broad in the organisation starting with the top management and then cascaded to all employees Training and education should explain the 'why' and 'how' of LSS to employees. Typical training would cover quality principles, problem-solving skills, teamwork, statistical tools and Lean and Six Sigma methodology.	(Albliwi et al. 2014; Alhuraish et al. 2017; Näslund 2013; Laureani et al. 2012; Coronado and Antony 2002; Hilton et al. 2008)
Linking LSS to customers	LSS projects are generated based on the voice of the customer (VOC). Projects should start and end with the customer needs, hence the importance of defining and linking LSS projects to customer requirements becomes critical. In a typical LSS project, VOC is translated to critical to quality (CTQ) factor. The CTQ analysis provides a method to translate the VOC	(Chakraborty and Tan 2012; Coronado and Antony 2002; Desai et al. 2012)

	into a measurable factor that can be used to build the LSS model. The above exercise serves to identify the customer (internal/external) needs, to select projects with high impact on customer satisfaction and understanding the market and evaluating it periodically.	
Organisational infrastructure	The organisational infrastructure supports the organisational readiness to launch LSS projects by ensuring that specific organisational characteristics are in place. For example, the creation of cross-functional teams within the organisation supported by employees dedicated entirely to Six Sigma deployment through the belt system training will create proper teamwork infrastructure to support LSS deployment.	(Coronado and Antony 2002)
Project Prioritisation selection, management, and tracking	LSS is driven by a strong project management methodology. Poor project management and tracking could lead to failure or delayed results. Selecting and prioritisation of projects becomes a critical factor to ensure maximum financial return to the organisation. LSS project selection is based on proejcts that will yield positive financial returns, address customer requirements and focus on poorly performing areas of the organisation.	(Coronado and Antony 2002; Pande et al. 2000; Harry and Schroeder 2000; Desai et al. 2012)
Aligning LSS projects to business objectives	LSS projects cannot be treated as a stand-alone effort and must be linked to strategy and business to ensure continuity and support. LSS projects should show a clear link to the organisational strategy and objectives including financial benefits. Conducting a financial appraisal of Six Sigma projects and targeting Six Sigma projects that have a direct impact on the financial and strategic operational goals of the organisation is a critical element for deployment.	(Shah and Din 2016; Coronado and Antony 2002)

Linking LSS to suppliers	It is usually beneficial to extend the deployment of LSS to suppliers. That will require an organisation to link its LSS application to its supply chain and work with its suppliers to minimise variation and maintain suppliers with high process capability. Involving suppliers in Six Sigma projects and partnering with suppliers who have implemented Six Sigma is another good example.	(Antony and Banuelas 2002; Pande et al. 2000; Desai et al. 2012).
Management of cultural change	Deploying LSS programme requires cultural change and organisational transformation. It is argued that for LSS to succeed, an organisation must transform and endure a significant 'psychological change in managers' and employees believes, attidudes and behaviours towards continual improvement'. Hence to successfully deploy LSS, an adjustment is needed in the culture, values and staff mindset to overcome the fear of change This will lead to lower resistance on the individual level when implementing Six Sigma. This can be achived through active communication channels, motivation and continous education on the why and how of LSS, showing the difference between LSS and other quality improvement initiatives and demonstrating the need for LSS in terms of benefits to the employees.	(Chakraborty and Tan 2012; Antony and Banuelas 2002; Noori 2015; Desai et al. 2012; Ahmad et al. 2016; Harry and Schroeder 2000) (Antony and Banuelas 2002; Anand 2015) (Ahmad et al. 2016)
Communication of information	An effective communication plan is critical to ensure that LSS objectives and benefits are explained to staff including how it works and how it will affect them. Further, communication includes spreading the word for LSS project results (positive and negative) to build on previous success and to learn from mistakes.	(Coronado and Antony 2002)
Linking LSS to employees	Creating a sense of ownership among employees will support LSS deployment. Involving employees who best understand their processes is highly suggsted. It is also suggested to use LSS accomplishments as one of the key measures for management performance and	(Coronado and Antony 2002; Desai et al. 2012)

Usage of problem-solving and statistical thinking tools	Understanding LSS different tools and techniques is critical to projects success. More importantly, a structured training programme (e.g. the belt system) will support the learning and usage of problem-solving and statistical tools. There are a number of Six Sigma and Lean tools that can be merged and used under an LSS programme. The understanding and proper usage of the seven quality tools in addition to other statistical tools combined with Lean tools such as VSM or 5S could be very valuable to the success of LSS projects.	(Antony and Banuelas 2002; Byrne 2003; Klefsjö et al. 2001)
Established LSS dashboard	Business practitioners argue that it is hard to manage and improve what you do not measure. Therefore, LSS activities need to be integrated into organisational measures and tracked through scorecards or dashboards. Clear goals and targets should be identified in a dashboard that is linked to business performance and customer needs.	(Tyagi et al. 2016; Waters 2016; Jeyaraman et al. 2010; Chakraborty and Tan 2012)
Incentive program	Having an incentive and performance management system that is tied to successful selection, participation and completion of LSS projects, will support deployment and will provide motivation to staff. Consequently, this may require the adjustment of human resources procedures to be more aligned with the principles of LSS approach. These adjustments may include linking organisational rewards and career growth to LSS projects success.	(Coronado and Antony 2002; Sharif 2011)
Understanding LSS methodology	To properly implement LSS methodology the two approaches (Lean and Six Sigma) and their related tools must be understood by employees. It is also critical to understand the DMAIC steps blended with Lean principles and tools and techniques during the implementation.	(Coronado and Antony 2002; Desai et al. 2012)
Availability of resources (financial, time)	LSS projects may fail if no resources are avaiable during LSS projects Resources may include time, IT, finicial, training and team members. The organisation capabilities and top management commitment to provide resources for LSS projects is critical to their success.	(Antony, Downey-Ennis, et al. 2007; Coronado and Antony 2002; Jeyaraman et al. 2010; Alsmadi et al. 2012)

APPENDIX C: Questionnaire Factors and Indicators

Categories	**Code**	**CSF**	**Set 1**	References	**Set 2** (Tran 2006)
Strategic	S01	Leadership and Visible top Management involvement and Commitment	• Executives are committed fully to the performance improvements • Executives are actively championing the performance initiatives. • Executives are actively communicating the performance commitments to all staff.	(Hilton et al. 2008)	• There is a lot of upper management involvement and commitment for LSS initiatives at my organisation • Upper management at my organisation is knowledgeable in LSS tools and techniques and they follow it closely
	S02	Management of cultural change	• Early and effective communication on the why and how of Lean Six Sigma • Showing the difference between Lean Six Sigma and other quality improvement initiatives • Demonstrating the need for Lean Six Sigma in terms of benefits to the employees	((Douglas et al. 2015; Desai et al. 2012)	• In general, the corporate culture in our organization supports using Six Sigma. • Our organizational environment such as people's perception and attitudes are in full support of Six Sigma
	S03	Availability of resources (financial, time)	• Our company has a dedicated budget head for Six Sigma implementation • Release of funds for any quality project is not streamlined and requires a lot of documentation and time • I feel that Six Sigma projects involve enormous financial resources	Dubey et al. 2015)	• My organisation makes funding readily available for LSS initiatives • There is a large financial budget at my organisation which allocated to LSS deployment (i.e. for resources et.)
	S04	Organisational infrastructure	• Creation of cross-functional teams within the organisation	(Douglas et al. 2015; Desai et al. 2012)	• According to the way that our organisation is set up, our organisational infrastructure really supports LSS • Within our LSS initiative, it can be easily seen that there exists a hierarchy

	S05	Linking LSS to customers	• Identification of customer (internal/external) needs • To implement projects with high impact on customer satisfaction • Understanding your market and evaluating it periodically	(Douglas et al. 2015; Desai et al. 2012)	• Our Six Sigma initiatives always start and end with our customers. • We constantly get feedback from customers and we tailor our Six Sigma efforts to address the customers' concerns.
	S06	Aligning SS projects to business objectives	• Financial appraisal of Six Sigma projects • Target Lean Six Sigma projects on improvements that have a direct impact on the financial and operational goals of the company	(Douglas et al. 2015; Desai et al. 2012)	• Six Sigma is integrated into our business such as into our vision, into the way we do things, into our strategy etc. • Six Sigma is evident throughout all of our departments / divisions all through the organization.
Tactical	T01	Linking LSS to suppliers	• To involve suppliers in Six Sigma projects • To have suppliers who have implemented Six Sigma	(Douglas et al. 2015; Desai et al. 2012)	• Our suppliers are fully aware of Six Sigma and are trying to use, thinking about using or are using it themselves. • Our Six Sigma efforts are coordinated with that of our suppliers to get the full benefit of Six Sigma in our organization.
	T02	Training and education	• Training in quality principles is important. • Training in problem-solving skills is important. • Training in teamwork facilitation, structure and action are important. • General awareness training in performance improvement methodologies is important.	(Hilton et al. 2008)	• There are many hours of training that are involved before an employee can start on any Six Sigma effort. • The amount invested in training for Six Sigma is very large as compared to other business units within our organization

			• Training in teamwork facilitation, structure and action are important. • General awareness training in performance improvement methodologies is important.		• The amount invested in training for Six Sigma is very large as compared to other business units within our organization
	T03	Usage of problem-solving and Statistical thinking and tools	• To understand fully all steps of the DMAIC methodology • To adapt Lean Six Sigma methodology to your organisation • To use simple tools and techniques during Lean Six Sigma implementation	(Douglas et al. 2015; Desai et al. 2012)	• We fully understand the Six Sigma methodology, tools and techniques that are used in our processes. • We always use the DMAIC (Define, Measure, Analyze, Improve, Control) or DFSS (Design for Six Sigma) methodologies for all of our Six Sigma efforts. • In the Six Sigma efforts that we are involved in, we use Statistical techniques to analyze data. • We are deeply knowledgeable in the statistical techniques required for our Six Sigma efforts
	T04	Linking LSS to employees	• Employees understand the need for implementing Six Sigma • Employees are aware of what they need to change • Employees are eager to participate in Six Sigma projects • Employees are empowered to make project decisions independently • Employees are given sufficient time to work on projects	(Dubey, Gunasekaran, et al. 2015)	• Six Sigma is fully integrated into our HR department in that things that HR does is related directly or indirectly to Six Sigma. • My organization's incentive systems, motivational initiatives and hiring processes are optimized with Six Sigma in mind.
Operational	O01	Understanding LSS methodology	• The performance principles are included in the hospital's mission. • There is a need for high quality and health and safety standards.	(Hilton et al. 2008)	

	O02	Incentive programme	• To use Lean Six Sigma accomplishments as the key measure for management performance and compensation • To make Lean Six Sigma training mandatory for promotion consideration • To award monetary bonuses based on successful implementation of Lean Six Sigma projects	(Douglas et al. 2015; Desai et al. 2012)	• My organization offers many rewards which are directly related to our Six Sigma efforts. • Six Sigma initiatives get full recognition by the organization when a project is completed.
	O03	Communication of information	• Communication provides information about Six Sigma • Communication provides information about employee impact • Communication emphasize Six Sigma progress	(Dubey, Gunasekaran, et al. 2015)	• There is a lot of communication with respect to Six Sigma in our organization as to how we are doing. Both successes and failures are well communicated to employees. • Management always talks about how our Six Sigma initiatives are progressing
	O04	Established Lean Six Sigma dashboard	• Measuring performance in all areas is necessary. • Using charts and graphs to measure and monitor quality is helpful. • Employee training in statistical methods for measuring quality is necessary. • LSS results are used as tools to manage performance • LSS dashboard is available to employees • LSS dashboard is available to managers and supervisors	(Hilton et al. 2008; Jeyaraman & Teo 2010)	

			• LSS goals within the hospital are focused		
	O05	Project prioritisation selection, management, and tracking skills	• Project selection based on financial returns • Project prioritisation based on customer requirements • Project selection focused on poorly performing areas of the company • To develop project management skills • To establish a project scorecard	(Douglas et al. 2015; Desai et al. 2012)	• My organization believes that being able to prioritize, select, review and track projects is very important for using Six Sigma. • The projects that we select usually are those that we know will be successful when completed.
Hospital Performance	HP01	Patient Results	• The general mortality rate decreased last 1 year • Outpatients' satisfaction increased last 1 year • Readmission rate within 24 in emergency department decreased last 1 year • Length of stay decreased last 1 year • Services lead-time has decreased • Patient complaints have reduced	(Ali & Alolayyan 2013)	
	HP02	Staff And Work System Results	• Employees hours spent in education and training increase • The productivity of per employee per month increased • Employee satisfaction has increased • The turnover rate of employees has decreased • Information sharing has increased	(Ali & Alolayyan 2013)	
	HP03	Hospital Efficiency and Effectiveness Results	• Number of outpatients has increased	(Ali & Alolayyan 2013)	

			• Numbers of inpatients have increased • Number of general anaesthesia surgery has increased • General occupancy rate has increased • The productivity has improved • The hospital's reputation is improved • Number of service defects, errors, or breakdowns has decreased • Cost of quality has decreased		
	HP04	Flexibility Performance Results	• The waste has reduced • The competitive position of the hospital's has strengthened • Capacity to develop unique competitive profile has increased • Capability to provide specialised health care and services has increased	(Ali & Alolayyan 2013)	

APPENDIX D: Social Desirability Scale

Self Assessment

Dare You Say What You Think? The Social-Desirability Scale

Do you say what you think, or do you tend to misrepresent your beliefs to earn the approval of others? Do you answer questions honestly, or do you say what you think other people want to hear?

Telling others what we think they want to hear is making the socially desirable response. Falling prey to social desirability may cause us to distort our beliefs and experiences in interviews or on psychological tests. The bias toward responding in socially desirable directions is also a source of error in the case study, survey, and testing methods. You can complete the Social-Desirability Scale devised by Crowne and Marlowe to gain insight into whether you have a tendency to produce socially desirable responses.

Directions: Read each item and decide whether it is true (T) or false (F) for you. Try to work rapidly and answer each question by clicking on the T or the F. Then click on Total Score to access the Scoring Key and interpret your answers.

1. T F Before voting I thoroughly investigate the qualifications of all the candidates.
2. T F I never hesitate to go out of my way to help someone in trouble.
3. T F It is sometimes hard for me to go on with my work if I am not encouraged.
4. T F I have never intensely disliked anyone.
5. T F On occasions I have had doubts about my ability to succeed in life.
6. T F I sometimes feel resentful when I don't get my way.
7. T F I am always careful about my manner of dress.
8. T F My table manners at home are as good as when I eat out in a restaurant.
9. T F If I could get into a movie without paying and be sure I was not seen, I would probably do it.
10. T F On a few occasions, I have given up something because I thought too little of my ability.
11. T F I like to gossip at times.
12. T F There have been times when I felt like rebelling against people in authority even though I knew they were right.
13. T F No matter who I'm talking to, I'm always a good listener.
14. T F I can remember "playing sick" to get out of something.
15. T F There have been occasions when I have taken advantage of someone.
16. T F I'm always willing to admit it when I make a mistake.
17. T F I always try to practice what I preach.
18. T F I don't find it particularly difficult to get along with loudmouthed, obnoxious people.
19. T F I sometimes try to get even rather than forgive and forget.
20. T F When I don't know something I don't mind at all admitting it.
21. T F I am always courteous, even to people who are disagreeable.
22. T F At times I have really insisted on having things my own way.
23. T F There have been occasions when I felt like smashing things.
24. T F I would never think of letting someone else be punished for my wrong-doings.
25. T F I never resent being asked to return a favor.
26. T F I have never been irked when people expressed ideas very different from my own.
27. T F I never make a long trip without checking the safety of my car.
28. T F There have been times when I was quite jealous of the good fortune of others.
29. T F I have almost never felt the urge to tell someone off.
30. T F I am sometimes irritated by people who ask favors of me.
31. T F I have never felt that I was punished without cause.
32. T F I sometimes think when people have a misfortune they only got what they deserved.
33. T F I have never deliberately said something that hurt someone's feelings.

SOURCE: D. P. Crowne and D. A. Marlowe, A new scale of social desirability independent of pathology, *Journal of Consulting Psychology* 24 (1960): 351.

Reset | Total Score

Source:

https://www.cengage.com/resource_uploads/downloads/0495092746_63626.pdf

APPENDIX E: Questionnaire Evaluation Sheet

1. Questionnaire

Items	Unsuitable	Moderate	Suitable
Number of pages			
Time usage			
Text size			
Language			
Interest/attractiveness			
Pattern/design			
Order of questions			

2. Questions

Items	Unsuitable	Moderate	Suitable
Usefulness			
Instruction			
Clearness (Understanding)			
Terminology (Definition)			
Suit of ranking			

Please indicate the question number and indicate the cause of unsuitableness and suggest improvement

Question #	Repetitive	Boring	Unclear	Difficult	Bias	Suggestions

APPENDIX F: Experts Details for Questionnaire Validation

	Position	Feedback Method
Academician # 1	Senior consultant –Meirc Training and Consulting	Protocol analysis
Academician # 2	Partner- –Meirc Training and Consulting	Workshop
Academician # 3	Chairman–Meirc Training and Consulting	Workshop
Academician # 4	Partner- –Meirc Training and Consulting	Email
Marketing and Questionnaire design expert	Partner- –Meirc Training and Consulting	Workshop
Marketing and Questionnaire design expert	Partner- –Meirc Training and Consulting	Protocol analysis
LSS Expert 1	Assistant Professor in the field of Lean Six Sigma at King Abdulaziz University,	Email
LSS Expert 2	Management University of Africa	Email
LSS Expert 3	Associate Professor Montpellier Business School	Email
LSS Expert 4	University of Strathclyde	Email
LSS Expert 5	Associate Professor | Department of Business Administration & Marketing. Birzeit University	Email
LSS Expert 6	Assistant Professor, Hamdan Bin Mohammed Smart University, Dubai, UAE	Email
LSS expert 7	LSS PhD Student and Assistant Professor in Management at HW university	Email
LSS expert 8		Email
LSS expert 9	Associate professor, Department of Industrial Engineering School of Engineering , The University of Jordan	Meeting and email
LSS expert 10	Assistant Professor at Amrita School of Business, Cochin Area, India	Email

APPENDIX G: Expert Opinion on the Survey Questionnaire

Channels used: Email, Workshop Based, Protocol analysis		
Expert	Feedback	Action taken
Academician # 1	1. Length of survey is reasonable. It took 18 minutes to complete 2. Suggested to shorten the introduction letter and remove some parts (e.g. "Please complete the questionnaire based on your honest judgment and give your valuable comments. Some of the questions may seem to be similar to one another, but each question addresses a unique issue. There is no right or wrong answer. I am mainly interested in your opinion on the issues") 3. Suggested to use one question to measure each CSF instead of two. 4. Questioned the difference between the terms 'moderately' and 'mildly' used in the Likert scale and their degree of difference. 5. Question 29: 'services lead-time has decreased' sounds vague to him 6. He suggested to have only question on ranking with weights – i.e. remove Q34-38 since question 32 can capture the same 7. In general, he was positive about the layout and structure.	• Item 2: Reduced the introduction email. • Item 6: Removed Q34-38 • Item 29 : Changed to 'Lead-time for hospital services has decreased.'
Academician # 2	1. Abbreviation such as LSS and DPMO should be spelt out 2. Consider reducing the number of questions 3. Q4: Consider changing as some hospitals could be included in more than one option 4. Consider neutral answer in your Likert scale 5. Other items are suitable	• Item 1 addressed • Item 2 addressed • Item 3: questions 4 rephrased • The author decided not to use neutral to avoid issues with analysis
Academician # 3	1. Length is appropriate 2. Spell out the abbreviation such as DMAIC and LSS 3. Question 28: Availability of resources should read lack of resources 4. Question 24: Suggested to use 'one of the key measures' instead of the key measure 5. Questioned how will the sample will be sent and how it will cover all hospitals in the UAE and suggested to run an initial survey to measure implementation in all UAE hospitals and then send the full survey to the ones that are implementing LSS	• Item 1: Indicated that LSS stands for Lean Six Sigma at the beginning of the survey. Item 3: Fixed • Item 4: Fixed

Academician # 4	1. Question # 5 (How many patient beds does your hospital have) May need a "?" at end. 2. Question #14: Aren't both Qs similar in meaning? 3. #22: 2nd Q isn't same as #14 in meaning? 4. #30 (How would you consider the results of Lean Six Sigma in your hospital so far) I would replace "consider" with either "categorize" or "describe".	• Item 1: Fixed • Item 4: Changed from consider to describe
Marketing and Questionnaire design expert # 1	1. Length is appropriate 2. What not consider benchmarking as a CSF? 3. Spell out the abbreviation such as DMAIC and LSS 4. Consistency using LSS and SS in Q32 5. Question 28: Availability of resources should read lack of resources	• Items 4 and 5 addressed
Marketing and Questionnaire design expert # 2	1. Suggested to trim the introduction letter to make it simpler and shorter 2. Felt that the questionnaire took more than 20 minutes and suggested to shorten it 3. Q 3, 5 ,8 etc..: Should have more space between options to avoid confusion 4. Q4: It could be confusing to have more than one type for type of hospital as some hospitals could be a private but also part of a multinational group and could be a joint venture 5. Q13: suggested to remove the leadership and stick with top management. Second element has two question. 6. Q14: Confusing as it is difficult between culture and organizational environment. One element is mild while the other is hard 7. Q15: Clarify what is head 8. Q21: No clear on the first element (Who is we). While the second element is not clear on the word 'many' 9. Q23: 2nd element is not very clear and rather rhetorical 10. Q25: Not clear (who is our) 11. Q26: The first element has two questions 12. Also shared some improvement on wording and sequence.	• Item 1: Fixed • Item 2: Will reduce the number of questions addressing CSFs • Item 3: Seems to be a visual issue as the online copy did not have this issue. • Item 4: Changed to only list private or governmental • Item 5-11: Fixed
LSS Expert # 1	1. Q5: Need to consider adding: what is the capacity of the hospital in terms of patients number	• Item 2: Fixed in all questionnaire • Item 3: Added to the question

	2. General: Use less abbreviation or explain them. Not all people understand them 3. Q9: Add "Tick all that applies" 4. Q11: You might say 'your LSS education level' 5. Section 2 of CSFs : instead of Lean six sigma you may write Lean and /Six Sigma ,, this will include Lean, Six Sigma and LSS 6. Q19: you may add: 7. we encourage our suppliers to deploy LSS and support them 8. Q21: not steps ,, phases of DMAIC 9. Q21 : what is many?? it will not give you any valuable result,, you can transfer this question to the previous section and give exact numbers e.g 1 to 5, 6 to 10 ... 10. Q24: Not clear 11. Q25: Not clear 12. Q27: not Professional terminology .. you could say for LSS deployment or for LSS success and sustainability 13. Q28: Change wording to "What are the most common challenges/barriers for LSS deployment OR implementation in your hospital?"	• Item 5: Added a note mentioning the LSS refers to Lean, Six Sigma or LSS • Item 9: Fixed and rephrased • Item 10 and 11 reworded • Item 12: Reworked • Item 13: Fixed
LSS Expert # 2	1. The biggest concern is the fact that there is not neutral point in the Likert scale - there is a debate among academics about the use of a neutral or not. 2. Q7 Add "s" to term in the question 3. Q20a Double questions - asks about quality and lean six sigma - not necessarily the same thing in the eyes of many 4. Q24a Double question - performance and compensation 5. Q25 not clear. Communication needs better definition 6. Q26a Double question - performance in all areas and LSS 7. Q29- Not clear. This question needs rewording -Indicate the degree to which you agree with the following statements about the impact of LSS	• On item 1: Decided to keep the Likert scale with no neutral option as explained earlier in the questionnaire design section. • Item 2: Fixed • Item 3: Removed the reference to quality • Item 7: Q29: Changed as suggested.
LSS Expert # 3	1. No comments- Just proofread is required	• Done
LSS expert # 4	1. It may be useful to capture how a hospital got to Lean Six Sigma: did they start with either Lean or Six Sigma first, or directly into Lean Six Sigma? It may be a useful dimension to consider, whether the way they got to Lean Six Sigma matter	• No action

LSS Expert # 5	1. In section 2, I would recommend listing all the statements in a table to indicate respondents' agreement with them. This will produce fewer pages. You can code the questions to be linked to the main factors (when it comes to….). 2. In section 3, I would recommend having the scale of not important, important, and critical. I would also recommend deleting q33-38 as the analysis should reveal the rank of the most important (critical) factors and the unimportant ones. 3. Give clear instructions if the answer is no deployment in Q8. 4. Give clear instructions for those who answered Q9, should they stop here or should they continue 5. I wonder why did you use a 1-6 Likert scale, why not 5 or 7 which will make the analysis easier when calculating the mean. In the case of 1-6 which you are using, how would interpret the mean values? For example a mean value of 3.5? is it agreement or disagreement? 6. Q28: I would recommend asking respondents to list the issues they faced without the limited 3 issues. The analysis should reveal the ranking of the issues faced.	• Item 1: Discussed this however decided to keep each CSF question alone. Reduced the number of questions. • Item 2: Deleted questions 33-38 • Item 3: The respondent will move to 'no deployment' section if the answer is no deployment • Item 4: The designed logic will take them to the last page • Item 5: The 1-6 Likert scale will avoid giving 'neutral' choices to the respondents. See section on questionnaire design for justification. Also the mean item scores are not relevant in this study, because a non-parametric method (PLS-SEM) is used to address the research questions and test the hypotheses. In PLS-SEM, the latent variables or constructs are not operationalized using mean item scores • Item 6: Removed the limitation on 3 issues
LSS expert # 6	1. Summarise the introduction letter –tool long 2. May need to add that wherever LSS is mentioned, it applies to lean or Six Sigma as well 3. Q13 a and b sub-questions seem to have the same meaning 4. Please consider shortening the total number of questions	• Item 1: Reduced the email text in the introduction • Item 2: clarified this in the introduction • Item 3: Rephrased and kept on question for each CSF

	5. Q20 (training and education related to Lean Six Sigma) may ask whether they focus on soft skills training 6. Q26b (measuring performance (Scorecards or dashboards) linked to Lean Six Sigma) is not clear 7. Q31 tools consider adding FMEA, Value stream mapping, SIPOC 8. Q31 No need for run chart just control chart 9. Q 31 consider adding other lean tools like error proof, quick change over, cell layout Kanban 10. Q33: why 6 perhaps 3 are enough 11. Q40: add 'and contribute to enhance quality.' 12. Q8: Add an option: Implemented before but failed	• Item 4: Fixed • Item 6: Rephrased • Item 7, 8 and 8: Addressed • Item 10: Removed this question • Item 12: Added
LSS expert # 7	1. In terms of the introduction, you may also consider offering to forward participants an executive summary of your research. Add to the conclusion a thank you 2. Indicated that it took 30 minutes to fill which too long. 3. Subjects seemed to jump about and perhaps the order could be reviewed 4. Q 6: How were these posts arrived at as there seems to be vagueness about some, i.e. might a specialist not also be a doctor and might it also be worthwhile classifying posts into medical and non-medical 5. Q 8: 'Your study is about Lean Six Sigma but you do not give an option if the hospital is applying any other form of CI, Lean only, Six Sigma, Kaizen etc. So the results may be a bit misleading if they simply say no to LSS' 6. Q 11: Needs an option for 'no formal role' 7. Q 13: Might need to put CSF in full and provide an introductory sentence to the section. 8. Q 14: The second option needs rewording to make it clearer 9. Q 24: Why only monetary reward and recognition many organisations offer different types than purely cash incentives 10. Q 25: Is very vague, not sure what purpose it serves, what communication from who to who etc. Does it overlap with 22? 11. Q 27: Does this overlap with Q18 12. Q 39: Hospital rather than a company?	• Item 1: There will be an introduction explaining the research objectives • Item 2: Decided to use one question per CSFs instead of two. This will reduce the time to fill • Item 4: Reviewed and amended • Item 5: Added Lean and Six Sigma • Item 6: Added 'no role' • Item 7 : fixed • Item 8: Reworded • Item 9: Reworded to include non-monetary • Item 10: Reworded • Item 12: Fixed
LSS expert # 8	1. You may want to add Educational as a category in the first section 2. No other issues reported	• None

	3. Suggested adding Jordan to the sample.	
LSS expert # 9	1. Length should be reduced 2. Suggested to use one question per CSF	• Item 1 and 2 addressed
LSS expert # 10	1. Check the order of questions and suitability of ranking	• Decided not to use neutral

APPENDIX H: Pilot and Main Study Questionnaire

Pilot Questionnaire:

Dear Healthcare, Quality or Lean Six Sigma Professional,

As you are one of the quality experts in the field of Healthcare, I do appreciate if you can fill the survey on Lean Six Sigma implementation reflecting on your experience when you did the Six Sigma training and your project. This is a pilot study. I will be reaching to you at a later stage so you may forward the final questionnaire to other professionals at your hospital who are involved in quality and Lean Six Sigma.

If you decide to leave your email address at the end of the survey, and in appreciation for your time and cooperation, your email will be entered in a raffle on one free Apple ipad Mini 4. The winner will be notified by email to arrange for delivery.

The success of this research depends on your support. It will take approximately 10-15 minutes to complete.

Many thanks for your valuable time and assistance in completing this questionnaire and hope you will have a great summer!

Click here for the link to the survey.

Note: Whenever the term "Lean Six Sigma" is used it may refer to Lean, Six Sigma or a combined approach.

Yours sincerely,

Fawzi Bawab: PhD Candidate
Heriot-Watt University, Edinburgh Business School
fab6@hw.ac.uk

Dr Lynne Baxter: Research supervisor

Adobe Acrobat
Document

Main study Questionnaire:

Dear Healthcare Quality or Lean Six Sigma Professional,

I hope this message finds you well.

This is an academic research questionnaire aimed at investigating the implementation of Lean Six Sigma in hospitals. The purpose of the research is to help professionals in quality and hospitals better understand the factors that impact the success of Lean Six Sigma implementation in healthcare.

I kindly ask you to fill the questionnaire below if you are part of quality or Lean Six Sigma team. If not, please forward this email to your colleagues in any of these areas: quality, excellence and senior management.

If you decide to leave your email address at the end of the survey, your details will be entered into a raffle and you could win an Apple Mini iPad 4. The winner will be notified by email and delivery will be arranged consequently.

The information gained from this questionnaire will be strictly confidential. The questionnaire will in no way identify you or your hospital. Please answer the questions freely according to your perception; there is no right or wrong answer.

Click here for the link to the survey.

The survey will take approximately 10 minutes to complete.

Thank you in advance for your time and cooperation.

Fawzi Bawab: PhD Candidate
Heriot-Watt University, Edinburgh Business School , UK

Dr Lynne Baxter: Research supervisor

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1. The term Lean Six Sigma or LSS are used to refer to Lean, Six Sigma or a combined approach.

* 1. I have read and understood the explanation provided to me in the cover email and voluntarily agree to participate in this study. If you disagree with this consent then please exit the survey. (Kindly note that this study only focuses on UAE hospitals)

◯ Yes

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2. Section 1: Demographic Data

2. Please indicate in which UAE Emirate is your hospital located?

◯ Abu Dhabi and surrounding regions ◯ Dubai

◯ Ajman ◯ Ras al-Khaimah

◯ Fujairah ◯ Umm al-Qaiwain

◯ Sharjah

* 3. How many full-time employees does your hospital have?

◯ less than 250 ◯ 250 - 500 ◯ 501 - 1,000 ◯ more than 1,000

* 4. Is your hospital?

◯ A government hospital ◯ A private hospital

◯ Other (please specify)

* 5. How many patient beds does your hospital have?

◯ <100 ◯ 101-200 ◯ 201-300 ◯ 301-500 ◯ >500

1

* 6. What is the current status of the hospital in terms of the following? (Tick all that apply)

- [ ] JCI accredited
- [ ] Won a local quality award
- [ ] ISO 9001 certified
- [ ] None of them
- [ ] Other (please specify)

* 7. Please indicate the extent to which Lean, Six Sigma or Lean Six Sigma is being implemented at your hospital? (The term Lean Six Sigma or LSS are used to refer to Lean, Six Sigma or a combined approach)

- Not implemented
- Implemented (whether currently using or used before)
- Implemented before but abandoned

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3. No Deployment reasons

8. If your hospital has not implemented any Lean Six Sigma projects please indicate the primary reason below.

- Lacking resources
- Lacking deployment talent
- Not enough information to deploy
- Don't need it
- No leadership buy-in
- Don't believe it works
- Other (please specify)

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4. Time and area of implementation

9. For how long has your hospital used or has been using Lean Six Sigma?

- 0-3 years
- 4-6years
- 7-9years
- 10 years or over

10. Please indicate the areas where Lean Six Sigma is applied (Or has been applied) in your hospital (Tick all that apply):

- [ ] Finance
- [ ] Procurement
- [ ] Human Resources
- [ ] Maintenance
- [ ] Customer Service
- [ ] IT
- [ ] Clinical
- [ ] Hospital Operations (e.g. Admissions)

Other (please specify)

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5. Section 2: Success Factors

* 11. Top Management are fully committed to performance improvements (e.g. LSS)

Strongly Disagree	Moderately disagree	Mildly disagree	Mildly agree	Moderately agree	Strongly agree
○	○	○	○	○	○

* 12. When it comes to introducing and managing culture change, the corporate culture in our organization supports using LSS.

Strongly disagree	Moderately disagree	Mildly disagree	Mildly agree	Moderately agree	Strongly agree
○	○	○	○	○	○

* 13. When it comes to introducing and managing resources, Our hospital has a dedicated budget for LSS implementation.

Strongly disagree	Moderately disagree	Mildly disagree	Mildly agree	Moderately agree	Strongly agree
○	○	○	○	○	○

* 14. We select and implement LSS projects with high impact on customer and patient satisfaction

Strongly Disagree	Moderately Disagree	Mildly Disagree	Mildly Agree	Moderately agree	Strongly Agree
○	○	○	○	○	○

* 15. When it comes to introducing and managing LSS organisational infrastructure, we adopt the creation of cross-functional teams within the hospital

Strongly Agree	Moderately Agree	Mildly Agree	Mildly Disagree	Moderately Disagree	Strongly Disagree
○	○	○	○	○	○

3

* 16. We target LSS projects that have a direct impact on strategic, financial or operational goals of the hospital.

Strongly Disagree	Moderately Disagree	Mildly Disagree	Mildly Agree	Moderately Agree	Strongly Agree
◯	◯	◯	◯	◯	◯

* 17. When it comes to aligning LSS projects with our suppliers, we involve suppliers in our LSS projects.

Strongly Disagree	Moderately Disagree	Mildly Disagree	Mildly Agree	Moderately Agree	Strongly Agree
◯	◯	◯	◯	◯	◯

* 18. When it comes to staff training and education related to LSS, we consider training in LSS principles important

Strongly Disagree	Moderately Disagree	Mildly Disagree	Mildly Agree	Moderately Agree	Strongly Agree
◯	◯	◯	◯	◯	◯

* 19. When it comes to usage of problem-solving and statistical tools within LSS, we use various tools and techniques during LSS implementation

Strongly Disagree	Moderately Disagree	Mildly Disagree	Mildly Agree	Moderately Agree	Strongly Agree
◯	◯	◯	◯	◯	◯

* 20. When it comes to linking LSS to our employees, our employees are eager to participate in LSS projects

Strongly Disagree	Moderately Disagree	Mildly Disagree	Mildly Agree	Moderately Agree	Strongly Agree
◯	◯	◯	◯	◯	◯

* 21. We fully understand the LSS methodology (DMAIC)

Strongly Disagree	Moderately Disagree	Mildly Disagree	Mildly Agree	Moderately Agree	Strongly Agree
◯	◯	◯	◯	◯	◯

* 22. When it comes to incentives, we use LSS accomplishments as one of the key measures for rewarding performance and compensation

Strongly Disagree	Moderately Disagree	Mildly Disagree	Mildly Agree	Moderately Agree	Strongly Agree
◯	◯	◯	◯	◯	◯

* 23. When it comes to communication linked to LSS, our hospital communication provides information about LSS projects and progress

Strongly Agree	Moderately Agree	Mildly Agree	Mildly Disagree	Moderately Disagree	Strongly Disagree
◯	◯	◯	◯	◯	◯

* 24. When it comes to measuring performance (Scorecards or dashboards) linked to LSS, LSS results are used as tools to manage performance that are linked to financial measures.

Strongly Disagree	Moderately Disagree	Mildly Disagree	Mildly Agree	Moderately Agree	Strongly Agree
◯	◯	◯	◯	◯	◯

* 25. When it comes to my own understanding of LSS, LSS has absolutely nothing to do with healthcare management.

Strongly Disagree	Moderately Disagree	Mildly Disagree	Mildly Agree	Moderately Agree	Strongly Agree
◯	◯	◯	◯	◯	◯

* 26. When it comes to project prioritisation, selection, management, and tracking linked toLSS, our project selection focuses on poorly performing areas of the hospital.

Strongly Disagree	Moderately Disagree	Mildly Disagree	Mildly Agree	Moderately Agree	Strongly Agree
◯	◯	◯	◯	◯	◯

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6. Section 2: Challenges for LSS implementation

27. What are the most common challenges/barriers for Lean Six Sigma deployment or implementation in your hospital? (Tick all that apply)

- ☐ Internal resistance
- ☐ Lack of tangible results
- ☐ Unmanaged expectations
- ☐ Poor project selection
- ☐ Competing projects
- ☐ Lack of leadership
- ☐ Lack of resources
- ☐ Changing business focus
- ☐ Low employee retention
- ☐ Change of management
- ☐ Poor training/coaching
- ☐ Other (please specify)

5

7. Section 3: Hospital performance perception

* 28. Indicate the degree to which you agree with the following statements about the impact of Lean Six Sigma

	Strongly Disagree	Moderately Disagree	Mildly Disagree	Mildly Agree	Moderately Agree	Strongly Agree
Outpatients' satisfaction has increased	◯	◯	◯	◯	◯	◯
Lead-time for hospital services has decreased	◯	◯	◯	◯	◯	◯
Employee satisfaction has increased	◯	◯	◯	◯	◯	◯
The turnover rate of employees has decreased	◯	◯	◯	◯	◯	◯
Productivity has improved (Since the implementation of LSS projects, did some of your operations improve with no increase in resources?)	◯	◯	◯	◯	◯	◯
Number of service defects, errors, or breakdowns has decreased	◯	◯	◯	◯	◯	◯
The competitive position of the hospital has strengthened	◯	◯	◯	◯	◯	◯
The waste in our operations and processes has been reduced	◯	◯	◯	◯	◯	◯

* 29. How would you describe the results of Lean Six Sigma in your hospital so far:

◯ Extremely successful ◯ Successful ◯ Not significant ◯ Negative ◯ Extremely negative

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8. Section 4: CSFs ranking

30. In your opinion, how important are the following factors in supporting Lean Six Sigma Deployment

	Not very important	Not Important	Important	Very Important	Critical
Visible top management commitment	○	○	○	○	○
Management of cultural change	○	○	○	○	○
Availability of resources (financial, time)	○	○	○	○	○
Organisational infrastructure	○	○	○	○	○
Linking LSS to customers	○	○	○	○	○
Aligning LSS projects to business objectives	○	○	○	○	○
Linking LSS to suppliers	○	○	○	○	○
Training and education	○	○	○	○	○
Usage of problem-solving and statistical thinking tools	○	○	○	○	○
Linking LSS to employees	○	○	○	○	○
Understanding LSS methodology	○	○	○	○	○
Incentive programme	○	○	○	○	○
Communication of information	○	○	○	○	○
Established LSS dashboard	○	○	○	○	○
Project prioritisation selection, management, and tracking skills	○	○	○	○	○

Other (please specify)

9. Your answers will NOT be attributed to either yourself or to any organisation

31. How do you perceive the future of Lean Six Sigma within your hospital?

◯ Growing in importance ◯ Becoming less important

32. What is your hospital's name?

33. If you are interested in taking part in the next step of the research, which consists of a 30 minutes semi-structured interview, please leave your name and email address or phone number here:

Name

Email/Phone number

34. If you are interested in participating in the raffle and/or to receive the consolidated results of the research, please leave your email address here:

8

APPENDIX I: Interviewees Profiles

#	Job title	Hospital Details	Interview duration (Minutes
I1	Director of Quality and Patient Safety	Tertiary private- Dubai	45
I2	Quality and Patient Safety Officer	Tertiary private- Dubai	60
I3	Risk and Quality manager	Speciality Private-Dubai	45
I4	Manager-Quality and Performance Improvement Department	Tertiary private- Sharjah	60
I5	Chief Quality Officer	Tertiary Governmental- Abu Dhabi and surrounding area	60
I6	Quality Manager	Tertiary Governmental- Abu Dhabi and surrounding area	60
I7	Patient Safety and quality education officer	Tertiary Governmental- Abu Dhabi and surrounding area	45
I8	Quality Manager	Secondary private- Abu Dhabi and surrounding area	45

APPENDIX J : Interview Topic Guide

<table>
<tr><td>Greeting and introduction
Thank you
Purpose
Confidentiality
Duration
How the interview will be conducted
Opportunity for Questions</td><td>Thank you for taking the time to meet with me. I would like to discuss your experience with relation to the implementation of LSS at your hospital. Specifically, I am doing my PhD study about LSS in hospitals. The interview should take around an hour. While I will be taking some notes, I would like to record the session because I don't want to miss any of your comments. Will that be okay with you? All responses will be kept confidential. Any information mentioned in my study, will not identify you as the respondent. You also may end the interview at any time.

· Are there any questions about what I have just explained?

· Are you willing to participate in this interview?</td></tr>
<tr><td>Demographic Details</td><td>No of staff
Hospital Type
No of beds
Accreditation</td></tr>
<tr><td colspan="2">When did your hospital begin being interested in LSS?
Tell me about the early projects – how did they go? Then What LSS projects are happening now?
How did the hospital start the LSS journey?
What do you think is critical to the success of LSS?
How does the hospital measure its processes? What does the hospital view as good performance? Please can you give me examples?
Can you please share your perception and knowledge on the impact of LSS on hospital measures?
How did the implementation of LSS go? How did the employees engage with it? How did the hospital resource the process?
If you were advising a hospital manager how best to go about implementing LSS what would you say? (What are the top 3 factors you would consider important so LSS can succeed?)
Is there anything more you would like to add?
Thank you again. I hope you will not mind if I need to contact you again to clarify an issues once I transcribe.</td></tr>
</table>

APPENDIX K: Details of SEM and ISM Sudies

Source	Sector	Objective	Main findings	Method
(Salaheldin 2009)	small and medium-sized enterprises (SMEs)	To identify the CSFs of TQM implementation and to evaluate their impact on the primary measures (operational performance) and secondary measures (organizational performance	There is a substantial positive effect of the TQM implementation on both the operational and the organizational performance	SEM
(Boon Sin et al. 2015)	manufacturing firms	To investigate the relationship between organizational knowledge creation processes (socialization, externalization, combination, and internalization) in Six Sigma project, knowledge, Six Sigma project success, and organizational performance	The organizational knowledge creation processes positively affect knowledge. Knowledge positively affects Six Sigma project success, and Six Sigma project success leads to improved organizational performance	SEM
(Zakuan et al. 2010)	NA	To propose a model based on TQM constructs and impact on organisational performance	Proposed Conceptual model	SEM
(Fotopoulos and Psomas 2010)	Manufacturers (66 per cent). Service providers (17 per cent) Wholesale traders (17 per cent)	To determine the relationships between TQM factors and organizational performance	Factors significantly affect companies' performance with respect to their internal procedures, customers, market share and the natural and social environment	SEM

(Soti et al. 2010)	Indian industries	To study the enablers of Six Sigma and to establish the relationship among them	Developed an ISM-based model that indicated that “effective top management leadership role”, “availability of funds” and “availability of expert training” are strategic requirements; “organizational culture”, “organizational infrastructure”, “quality maturity level of organization”, and “employees’ adaptability and flexibility towards learning” are tactical requirements. Indicated that “Statistical thinking”, “committed workforce”, “reliable data gathering and retrieval system”, and “technical competence” are operational requirements for Six Sigma applications	ISM
(Kumar and Sharma 2017)	NA	To explore the CSFs for TQM implementation	Provided ISM hierarchy level of all 14 factors from top to bottom level and critical input for TQM implementation	ISM
(Dubey et al. 2016)	Manufacturers	To identify enablers of Six Sigma implementation from existing research and sort them according to their driving power and dependence using MICMAC analysis. To develop a contextual framework	Suggested a MICMAC model	ISM

(Talib and Rahman 2015)	Hospitals-India	To develop a comprehensive framework in order to identify, rank and classify key quality dimensions for healthcare establishments To understand the contextual relationship between them for growth and development of Indian healthcare establishments	It identified all the critical quality dimensions of establishments It Proposed an integrated model for sustainable hospital services using ISM and MICMAC approach	ISM
(Kuvvetli et al. 2016)	All sectors with 52% in automotive-Turkey	To determine the factors affecting the level of success Six Sigma projects	It highlighted project selection and its scope, quality culture and defining and measuring metrics as the top factors that are affecting success levels of Six Sigma projects	SEM
(Kaynak 2003)	US organisations	To identify the relationships among TQM practices and examine the direct and indirect effects of these practices on various performance levels	Reported a positive relationship between the extent to which companies implement TQM and firm performance. This	SEM
(Habidin and Yusof 2012)	Malaysian automotive industry	To investigate and perform structural analysis of LSS and Organizational Performance To provide additional insight into the relationship between LSS and Organizational Performance by examining the effects of ISO 14001 certification as a moderator	Indicated that ISO 14001 certification does not significantly moderate the relationship between LSS and Organizational Performance in the Malaysian automotive industry. However, the Organizational Performance values for ISO 14001 certified companies are higher than those without ISO 14001 certification	SEM
(Khaidir et al. 2013)	Malaysian Healthcare	To review structural analysis of the Six Sigma and organizational performance	Suggested a proposed model between Six Sigma practices and organizational performance	NA

(Lo et al. 2016)	SMEs Malaysia	To examine the relationship between the determinants of organizational performance such as top management support, customer focus, employees' orientation, technology orientation, and entrepreneurial orientation	Highlighted that technology and entrepreneurial orientations are significant success factors for SMEs in terms of financial and non-financial performance. Top management support is found to be significantly and positively related to financial performance	SEM
(Demirbag et al. 2006)	SMEs-Turkish textile industry	To determine the critical factors of total quality management and to measure their effect on organizational performance	Indicated that there is a strong positive relationship between TQM practices and non-financial performance of SMEs, while there is only weak influence of TQM practices on financial performance of SMEs. With only a mediating effect of non-financial performance that the TQM practices have a strong positive impact on financial performance of SMEs	SEM
(Prajogo and Sohal 2003)	Australian Organisations	To examine the fit of TQM practices in mediating the relationship between organisation strategy and organization performance	Indicated that TQM is positively and significantly related to differentiation strategy, and it only partially mediates the relationship between differentiation strategy and three performance measures (product quality, product innovation, and process innovation) Indicated that TQM needs to be complemented by other resources to more effectively realize the strategy in achieving a high level of performance, particularly innovation	
(Carmona-Márquez et al. 2016)	Spanish organisations-62% manufacturing	To study relationships between CSFs and their sequencing during the implementation of TQM To link the strategic enablers, tactical drivers and instrumental drivers to business success	Revealed that instrumental drivers possess the highest variance explanation power over business performance outcomes and it is possible to identify a CSF implementation sequence that generates the greatest impact on business performance	SEM

(Ali et al. 2016)	electrical and electronics	To examine the relationship of CSFs of LSS practices on business performance, mediated by operational performance.	Indicated that management commitment, maturity level of LSS deployment and awareness of importance are critical factors having a significant impact on financial and non-financial performance Indicated that LSS training, resources allocation, the maturity level of LSS deployment and awareness of importance are significant factors toward operational performance Indicated that operational performance mediates the relationship between maturity level of deployment and awareness of importance on business performance Suggested Success model for LSS practices and relationship with performances (see	SEM

APPENDIX L: Non-Repsonse bias T-test Results

Top Management commitmment

Group Statistics

	Response group	N	Mean	Std. Deviation	Std. Error Mean
CSF1	0	57	4.8596	1.28784	.17058
	1	44	5.1136	.96968	.14618

Independent Samples Test

CSF1	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	1.870	.175	-1.091	99	**.278**	-.25399	.23287	-.71605	.20807
Equal variances not assumed			-1.131	98.952	**.261**	-.25399	.22465	-.69974	.19177

Project selection, prirportisation and tracking

Group Statistics

	Response group	N	Mean	Std. Deviation	Std. Error Mean
CSF15	0	57	4.7193	1.29221	.17116
	1	44	4.7727	1.09680	.16535

Independent Samples Test

CSF15	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	1.928	.168	-.220	99	.826	-.05343	.24306	-.53572	.42886
Equal variances not assumed			-.225	98.065	.823	-.05343	.23798	-.52569	.41883

APPENDIX M: Reported Application of CSFs

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
We fully understand the Lean Six Sigma methodology (DMAIC)	0.00% 0	3.96% 4	5.94% 6	30.69% 31	28.71% 29	30.69% 31	101	4.76

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Our employees are eager to participate in Lean Six Sigma projects	0.00% 0	2.97% 3	14.85% 15	39.60% 40	26.73% 27	15.84% 16	101	4.38

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
We use Lean Six Sigma accomplishments as one of the key measures for rewarding performance and compensation	7.92% 8	7.92% 8	27.72% 28	26.73% 27	15.84% 16	13.86% 14	101	3.76

	STRONGLY AGREE	MODERATELY AGREE	MILDLY AGREE	MILDLY DISAGREE	MODERATELY DISAGREE	STRONGLY DISAGREE	TOTAL	WEIGHTED AVERAGE
Our organisational communication provides information about Lean Six Sigma projects and progress	5.94% 6	12.87% 13	28.71% 29	21.78% 22	12.87% 13	17.82% 18	101	3.24

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Lean Six Sigma results are used as tools to manage performance that are linked to financial measures	6.93% 7	8.91% 9	18.81% 19	26.73% 27	19.80% 20	18.81% 19	101	4.00

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Our project selection focuses on poorly performing areas of the hospital	2.97% 3	2.97% 3	5.94% 6	22.77% 23	35.64% 36	29.70% 30	101	4.74

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
We use various tools and techniques during Lean Six Sigma implementation	0.00% 0	3.96% 4	3.96% 4	20.79% 21	38.61% 39	32.67% 33	101	4.92

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Top Management are fully committed to performance improvements	0.99% 1	3.96% 4	2.97% 3	13.86% 14	31.68% 32	46.53% 47	101	5.11

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
In general, the corporate culture in our organization supports using Lean Six Sigma.	0.99% 1	2.97% 3	5.94% 6	25.74% 26	40.59% 41	23.76% 24	101	4.73

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
Our hospital has a dedicated budget for Lean Six Sigma implementation	12.87% 13	4.95% 5	16.83% 17	35.64% 36	16.83% 17	12.87% 13	101	3.77

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
We select and implement projects with high impact on customer and patient satisfaction	1.98% 2	0.99% 1	1.98% 2	11.88% 12	36.63% 37	46.53% 47	101	5.20

	STRONGLY AGREE	MODERATELY AGREE	MILDLY AGREE	MILDLY DISAGREE	MODERATELY DISAGREE	STRONGLY DISAGREE	TOTAL	WEIGHTED AVERAGE
We adopt the creation of cross-functional teams within the hospital	20.79% 21	21.78% 22	14.85% 15	8.91% 9	16.83% 17	16.83% 17	101	3.70

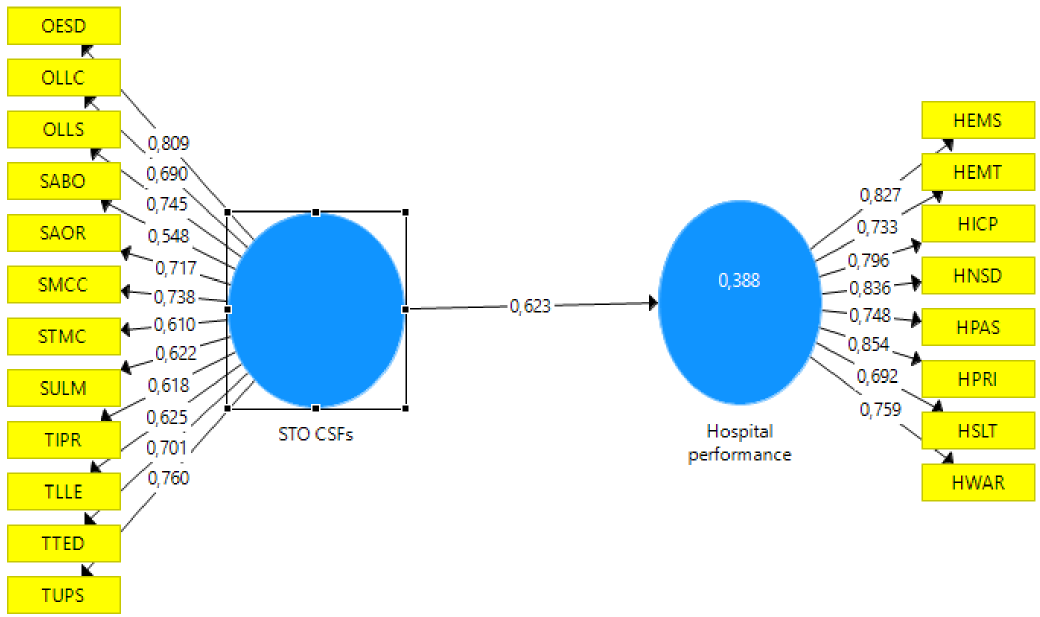
	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
We target Lean Six Sigma projects that have a direct impact on strategic, financial or operational goals of the hospital	2.97% 3	2.97% 3	2.97% 3	17.82% 18	31.68% 32	41.58% 42	101	4.97

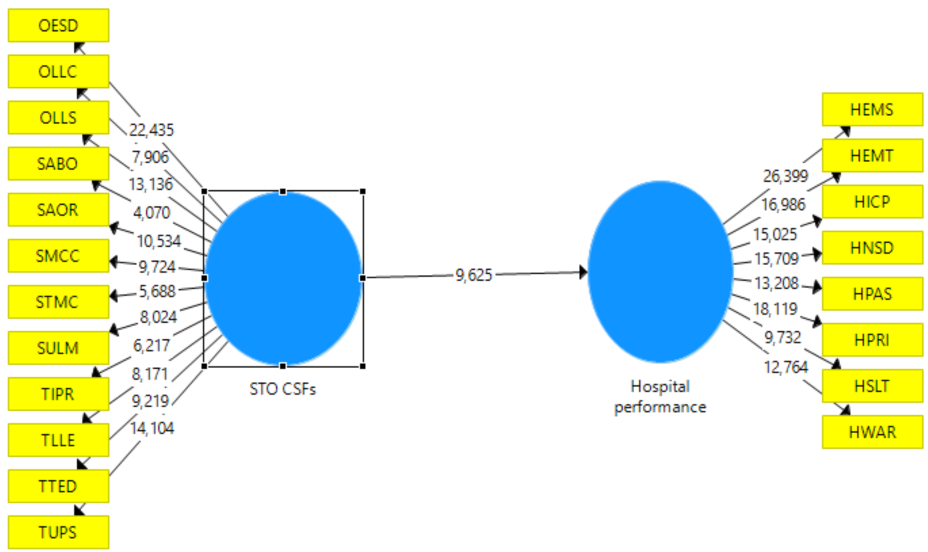
	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
We involve suppliers in our Lean Six Sigma projects	6.93% 7	12.87% 13	28.71% 29	24.75% 25	12.87% 13	13.86% 14	101	3.65

	STRONGLY DISAGREE	MODERATELY DISAGREE	MILDLY DISAGREE	MILDLY AGREE	MODERATELY AGREE	STRONGLY AGREE	TOTAL	WEIGHTED AVERAGE
We consider training in Lean Six Sigma principles important	0.00% 0	2.97% 3	4.95% 5	20.79% 21	36.63% 37	34.65% 35	101	4.95

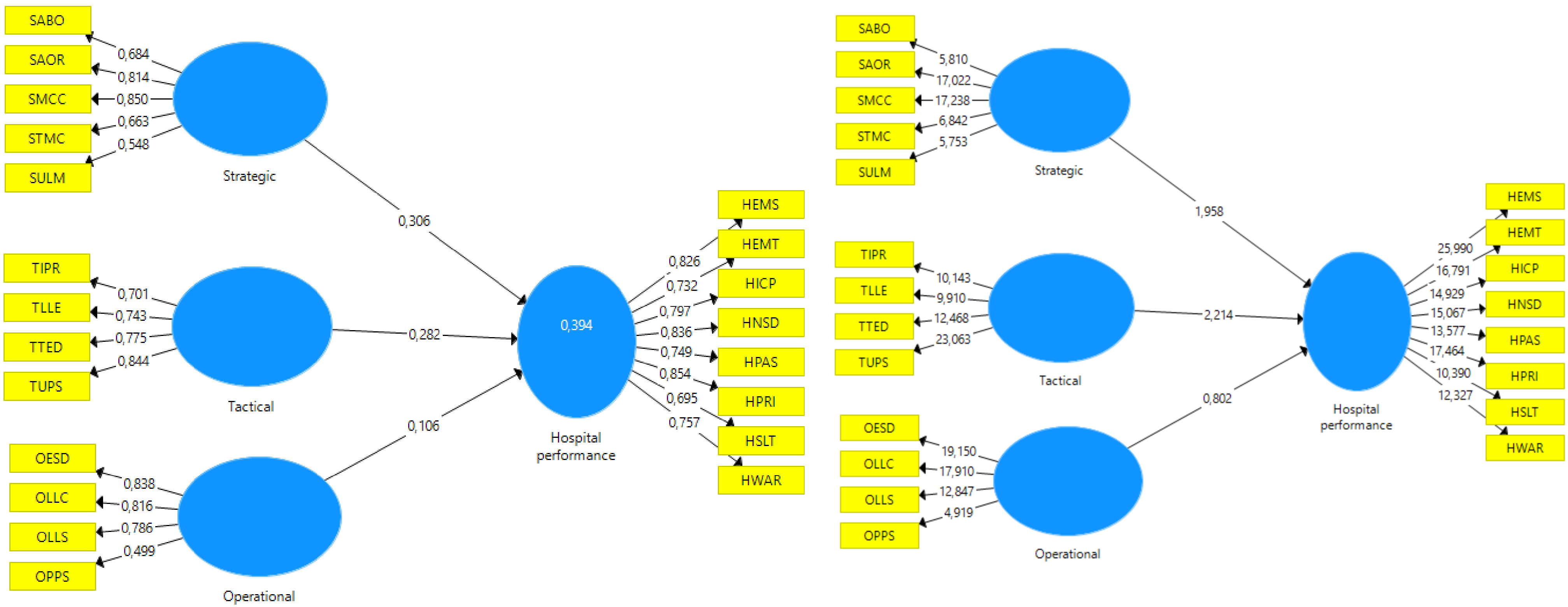
APPENDIX N: SmartPLS Output Graphs

Model A: Measurment and path analysis

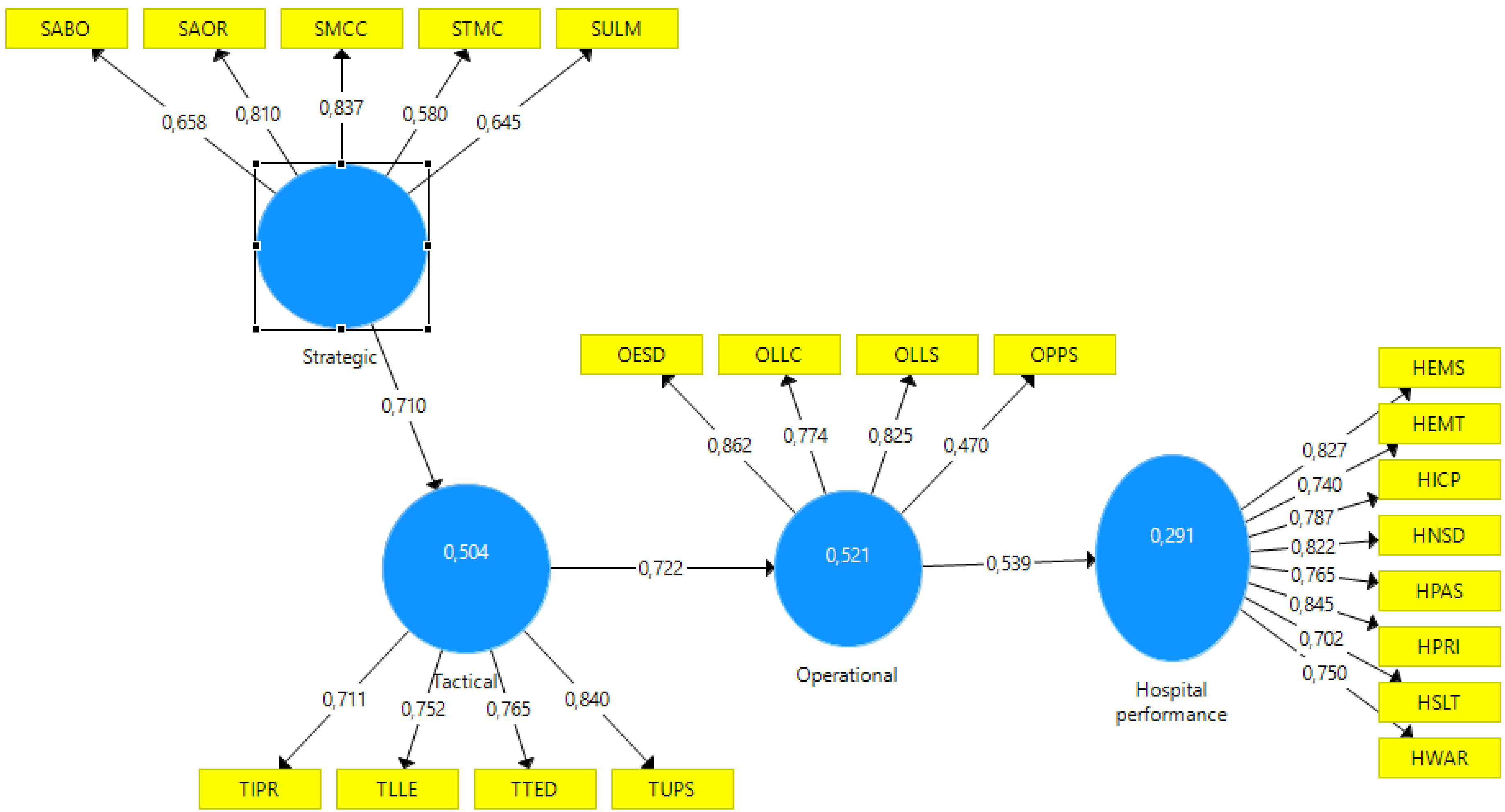




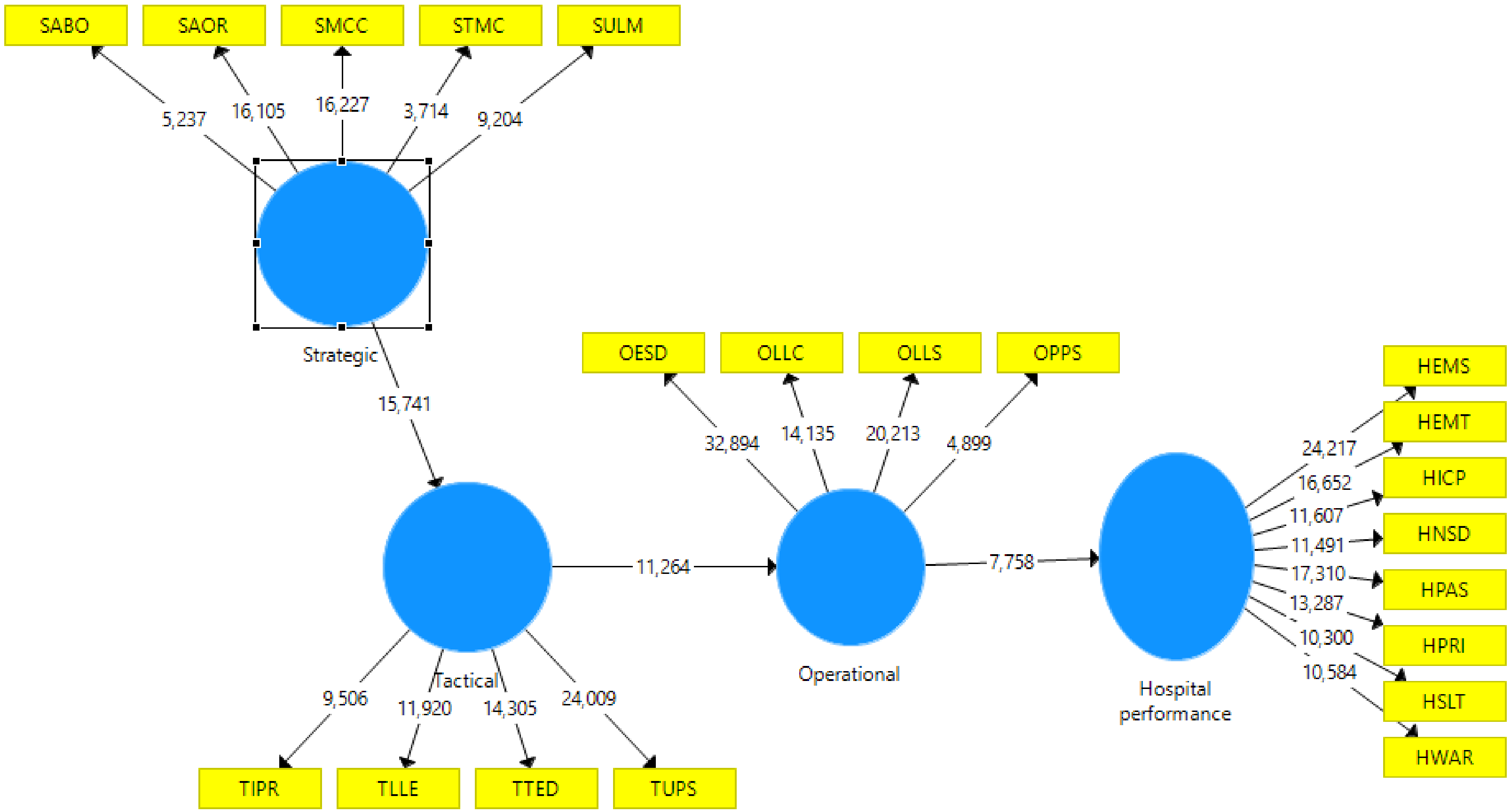
Model B: Measurment and path analysis



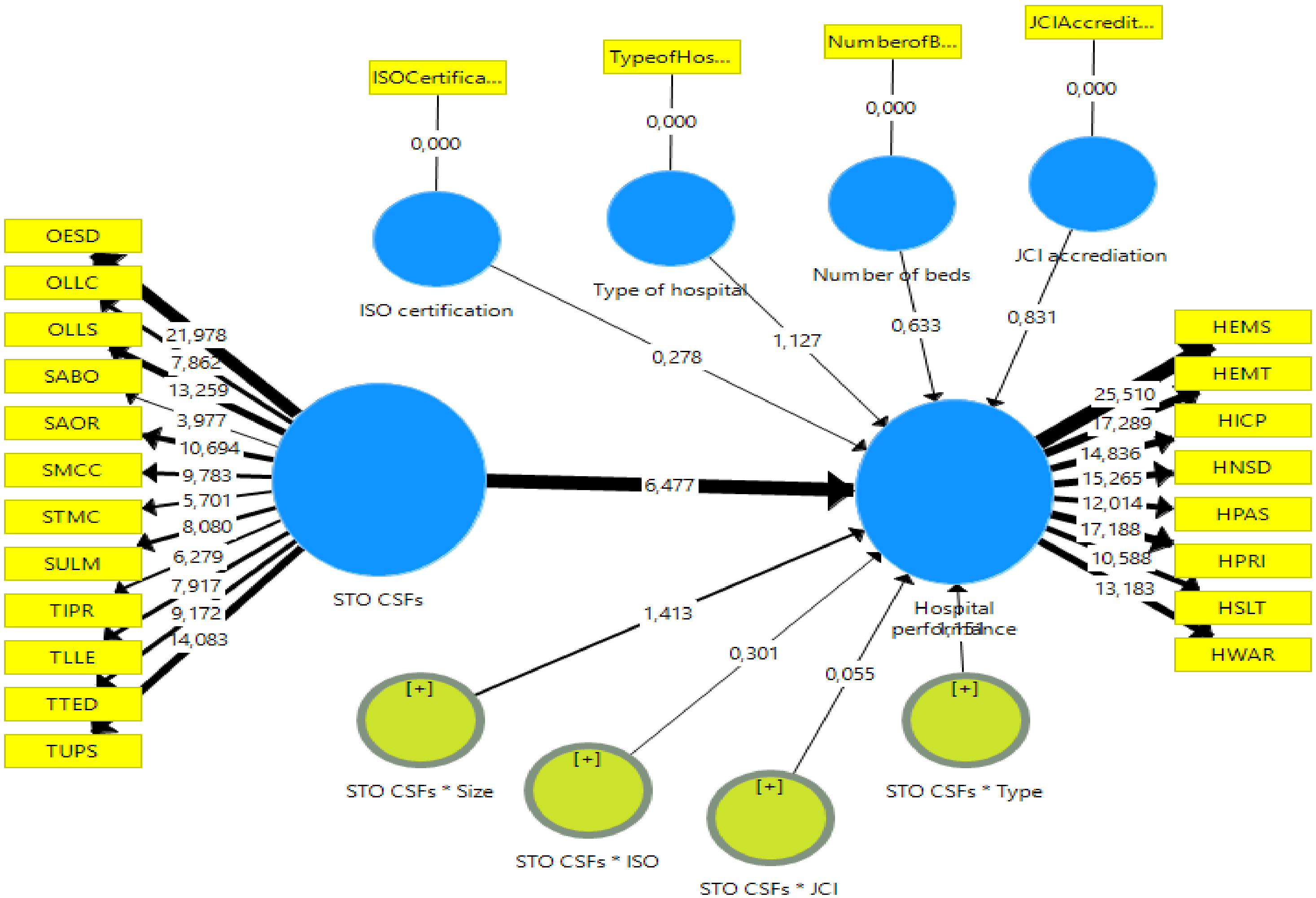
Model C: Measurment analysis



Model C: Path analysis



Moderators analysis



APPENDIX O: ISM Iterations

First iteration

CSF	Reachability Set	Antecedents Set	Intersection Set	Level
1	1 2 5 6 7 8 9 10	1 2	1 2	
2	1 2 4 5 6 7 8 9 10	1 2	1 2	
3	3 12 13 14 15	3 4 8 15	3 15	
4	3 4 11 14 15	2 4 5 6 10 11	4 11	
5	4 5 6	1 2 5	5	
6	4 6 11 15	1 2 5 6	6	
7	7 10 11	1 2 7	7	
8	3 8 14 15	1 2 8 9	8	
9	8 9 15	1 2 9	9	
10	4 10 11	1 2 7 10	10	
11	4 11 15	4 6 7 10 11	4 11	
12	**12**	**3 12 14 15**	**12**	**I**
13	**13**	**3 13 14 15**	**13**	**I**
14	12 13 14	3 4 8 14 15	14	
15	3 12 13 14 15	3 4 6 8 9 11 15	3 15	

2nd iteration

CSF	Reachability Set	Antecedents Set	Intersection Set	Level
1	1 2 5 6 7 8 9 10	1 2	1 2	
2	1 2 4 5 6 7 8 9 10	1 2	1 2	
3	3 14 15	3 4 8 15	3 15	
4	3 4 11 14 15	2 4 5 6 10 11	4 11	
5	4 5 6	1 2 5	5	
6	4 6 11 15	1 2 5 6	6	
7	7 10 11	1 2 7	7	
8	3 8 14 15	1 2 8 9	8	
9	8 9 15	1 2 9	9	
10	4 10 11	1 2 7 10	10	
11	4 11 15	4 6 7 10 11	4 11	
14	**14**	**3 4 8 14 15**	**14**	**II**
15	3 14 15	3 4 6 8 9 11 15	3 15	

3rd iteration

CSF	Reachability Set	Antecedents Set	Intersection Set	Level
1	1 2 5 6 7 8 9 10	1 2	1 2	
2	1 2 4 5 6 7 8 9 10	1 2	1 2	
3	**3 15**	**3 4 8 15**	**3 15**	**III**
4	3 4 11 15	2 4 5 6 10 11	4 11	
5	4 5 6	1 2 5	5	
6	4 6 11 15	1 2 5 6	6	
7	7 10 11	1 2 7	7	
8	3 8 15	1 2 8 9	8	
9	8 9 15	1 2 9	9	
10	4 10 11	1 2 7 10	10	
11	4 11 15	4 6 7 10 11	4 11	
15	**3 15**	**3 4 6 8 9 11 15**	**3 15**	**III**

Fourth Iteration

CSF	Reachability Set	Antecedents Set	Intersection Set	Level
1	1 2 5 6 7 8 9 10	1 2	1 2	
2	1 2 4 5 6 7 8 9 10	1 2	1 2	
4	4 11	2 4 5 6 10 11	4 11	**IIII**
5	4 5 6	1 2 5	5	
6	4 6 11	1 2 5 6	6	
7	7 10 11	1 2 7	7	
8	8	1 2 8 9	8	
9	8 9	1 2 9	9	
10	4 10 11	1 2 7 10	10	
11	4 11	4 6 7 10 11	4 11	**IIII**

Fifth Iteration

CSF	Reachability Set	Antecedents Set	Intersection Set	Level
1	1 2 5 6 7 9 10	1 2	1 2	
2	1 2 5 6 7 9 10	1 2	1 2	
5	5 6	1 2 5	5	
6	6	1 2 5 6	6	**V**
7	7 10	1 2 7	7	
9	9	1 2 9	9	**V**
10	10	1 2 7 10	10	**V**

Sixth iteration

CSF	Reachability Set	Antecedents Set	Intersection Set	Level
1	1 2 5 7	1 2	1 2	
2	1 2 5 7	1 2	1 2	
5	5	1 2 5	5	**VI**
7	7	1 2 7	7	**VI**

Seventh Iteration

CSF	Reachability Set	Antecedents Set	Intersection Set	Level
1	1 2	1 2	1 2	**VII**
2	1 2	1 2	1 2	**VII**