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THE IMPACT OF WORK ENVIRONMENT ON SUCCESSFUL
IMPLEMENTATION OF LEAN SIX SIGMA IN EMERGENCY
DEPARTMENT

by

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A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in the Department of Industrial Engineering and Management System
in the College of Engineering and Computer Science
at the University of Central Florida
Orlando, Florida

Summer Term
2020

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ABSTRACT

Continuous improvement (CI) is an initiative to improve the performance of processes in alignment with the customer needs and organizational strategy. Lean Six Sigma (LSS) is one of the most successful CI techniques in redesigning and improving significant processes to improve quality and eliminate waste. The healthcare sector has benefited from applying LSS due to its complicated work practices that face many challenges including increased expenditures and difficulties related to individual or community access to appropriate care. In particular, Emergency Departments (ED) have an important unit within healthcare organizations due to their essential role in providing urgent medical care services to patients. The aim of this doctoral research study is to develop a theoretical model using grounded theory to investigate the factors for successful LSS implementation in ED including how ED work environment affects the reduction of patient length of stay, which is one of the biggest issues that ED face. Therefore, the main objectives of this research are to: (1) investigate trends in the research area using systematic literature review, (2) develop an Initial Conceptual Framework including identifying the relationships between the variables of LSS implementation, (3) use an expert study where a group of experts will provide additional evidence regarding LSS implementation, and (4) test the model using survey questionnaire that examines the behavior of the variables. This research will be documented as a manuscript-style dissertation including four peer-reviewed academic journal articles each summarizing the results from a phase of this research. The results of this research will provide a conceptual model to guide the implementation of LSS in ED bringing the potential benefits of this approach to a critical department in healthcare organizations. Further, this research will inform future research by investigating the work environment effects on application of LSS.

To my limitlessly supportive Father, Abdullah

To my spiritual Mother, Aisha

To all my lovely siblings Eyad, Ekhlās, Ebtehal, and Mohammed

I dedicate this effort

Without you all,

I couldn't make it

ACKNOWLEDGMENTS

First, thanks to almighty ALLAH for giving me the strength and ability to understand learn and complete this dissertation.

Second, I am grateful to all of those with whom I have had the pleasure to work during this and other related projects. Their contributions are sincerely appreciated and gratefully acknowledged. I would especially like to thank Dr. Heather Keathley, the chair of my doctoral committee. As my academic advisor, she has taught me more than I could ever give her credit for here. She has shown me, by her example, what a good person should be.

I would like also to thank each of the members of my Dissertation Committee: Dr. Ahmed Elshennawy, Dr. Sandy Furterer, and Dr. Luis Rabelo, who provided me extensive professional guidance and taught me a great deal about scientific research.

To all friends and others who in one way or another, shared their support morally and spiritually, thank you.

TABLE OF CONTENTS

LIST OF FIGURES	xiii
LIST OF TABLES	xv
CHAPTER 1: INTRODUCTION	1
1.1 Problem Statement	3
1.2 Research Gap	5
1.3 Research Purpose	7
1.4 Research Objectives	8
1.5 Research Contribution Summary	8
1.6 References	11
CHAPTER 2: BACKGROUND	14
2.1 Implementation of Process and Quality Improvement Tools	17
2.2 Lean Six Sigma in Practice	20
2.3 Critical Success Factors of LSS Implementation	21
2.4 Work Environment	23
2.5 References	25
CHAPTER 3: RESEARCH METHODOLOGY	31
3.1 Research Framing	34
3.2 Conceptual Framework Development	36

3.3 Model Formulation	37
3.3.1 Expert Study.....	37
3.3.2 Grounded Theory	40
3.4 Model Development and Testing.....	45
3.4.1 Survey Questionnaire.....	46
3.4.2 Pilot test	46
3.4.3 Data collection	47
3.4.4 Statistical analysis.....	48
3.4.5 Limitation of survey.....	49
3.5 Discussion & Methodological Justification.....	49
3.6 References.....	53
CHAPTER 4: SYSTEMATIC LITERATURE REVIEW	56
4.1 Abstract.....	56
4.2 Introduction.....	57
4.2.1 Process and quality improvement in emergency care.....	60
4.3 Research Methodology	63
4.3.1 Research Strategy.....	65
4.4 Bibliometric Analysis	71
4.4.1 Matrix plot	77

4.5 Data Synthesis and Analysis.....	80
4.5.1 Lean Studies.....	80
4.5.2 Six Sigma Studies	87
4.5.3 Lean Six Sigma Studies	90
4.6 Results and Discussion	94
4.7 Conclusion	97
4.7.1 Limitations	99
4.7.2 Future Work.....	99
4.8 References.....	101
CHAPTER 5: CONCEPTUAL FRAMEWORK.....	110
5.1 Abstract.....	110
5.2 Introduction.....	111
5.3 Background.....	113
5.3.1 Lean Six Sigma in healthcare	114
5.3.2 Lean Six Sigma in emergency departments.....	115
5.3.3 Challenges of Lean Six Sigma in healthcare	116
5.4 Research Methodology	117
5.5 Descriptive Analysis.....	121
5.6 Results and Discussion	127

5.7 CSFs for Lean Six Sigma Implementation in Emergency Department	133
5.8 Summary of Existing Literature on Conceptual Frameworks of Lean Six Sigma	138
5.8.1 A conceptual framework of successful implementation of lean six sigma in emergency departments	140
5.9 Conclusion and Future Work	144
5.10 References	146
CHAPTER 6: EXPERT STUDY ROUND 1	154
6.1 Abstract	154
6.2 Introduction	155
6.3 Background	156
6.3.1 LSS implementation benefits, challenges, and critical success factors	158
6.3.2 State of LSS implementation in emergency departments	160
6.4 Research Methodology: Grounded Theory	162
6.4.1 Data collection	163
6.4.2 Participants	165
6.5 Analysis	168
6.5.1 Open coding	169
6.5.2 Axial coding	171
6.5.3 Selective coding	174

6.6 The Model of Lean Six Sigma Implementation in Emergency Departments	174
6.6.1 Validity	176
6.7 Results.....	177
6.7.1 Core phenomenon	178
6.7.2 Strategies.....	180
6.7.3 Contextual condition.....	181
6.7.4 Intervening condition.....	182
6.7.5 Consequences.....	183
6.7.6 Challenges.....	184
6.7.7 Accentuation	185
6.8 Discussion.....	186
6.9 Limitations	191
6.10 Conclusion and Future Work.....	192
6.11 References.....	197
CHAPTER 7: EXPERT STDUY ROUND 2	204
7.1 Abstract.....	204
7.2 Introduction.....	205
7.3 Background.....	207
7.3.1 Lean Six Sigma in healthcare	207

7.3.2 Critical success factor of Lean Six Sigma in healthcare	208
7.3.3 Impact of work environment factors on Lean Six Sigma implementation	209
7.4 Research Methodology	210
7.4.1 Sample size	213
7.4.2 Data analysis	214
7.5 Discussion of Results.....	215
7.5.1 Demographic information	215
7.5.2 CSFs of LSS implementation.....	219
7.5.3 Outcomes of LSS implementation success	222
7.5.4 The impact of work environment on the LSS implementation.....	223
7.6 Discussion.....	238
7.7 Conclusion, Limitation, and Future Work	242
7.8 References.....	244
CHAPTER 8: DISCUSSION AND RESULTS.....	253
8.1 Critical Success Factors of Lean Six Sigma	253
8.2 Successful Implementation of Lean Six Sigma in Emergency Departments	256
8.3 Impact of Work Environment	263
8.4 Summary	271
8.5 References.....	272

CHAPTER 9: CONCLUSION AND FUTURE WORKS.....	276
9.1 Summary of Contributions to Research.....	280
9.2 Implication for Practice	281
9.3 Limitation.....	284
9.4 Future Research	287
9.5 References.....	290
APPENDIX A: STUDY IRB APPROVAL.....	291
APPENDIX B: SURVEY INSTRUMENTS.....	293
APPENDIX C: SURVEY QUESTIONNAIRE ROUND 1	296
APPENDIX D: SURVEY QUESTIONNAIRE ROUND 2	301
APPENDIX E: MULTI-ITEM CONSTRUCT.....	308

LIST OF FIGURES

Figure 1.1 Guiding Conceptual Framework	6
Figure 2.1 Number of EDs and ED visits in the United States, 1995-2016	15
Figure 2.2: Number of ED visits per 1,000 patients in the United States, 1995-2016	16
Figure 3.1: Research design overview	32
Figure 3.2: Grounded Theory Process	41
Figure 4.1 Exclusion Criteria.....	68
Figure 4.2 Study selection process for the literature review.....	70
Figure 4.3 Publication per year.....	72
Figure 4.4 Research Methodologies Used in the Final Paper Set.....	74
Figure 4.5 Continues Improvement Tools	76
Figure 4.6 Matrix Plot for the number of studies in different research methodology vs. year.....	78
Figure 4.7 Matrix Plot for number of studies using different CI tools vs. year.....	79
Figure 4.8 Improved Measures in Emergency Departments	96
Figure 5.1 The Content Analysis process	119
Figure 5.2 A conceptual framework of CSFs of LSS implementation in EDs.....	141
Figure 6.1 LSS tools	158
Figure 6.2 Axial coding paradigm for LSS implementation in EDs.....	173
Figure 6.3 Final model of grounded theory for LSS implementation in EDs.....	175
Figure 6.4 A summary of grounded theory model of LSS implementation	194
Figure 7.1 Success rate of LSS projects.....	219
Figure 7.2 CSFs of LSS projects	221

Figure 7.3 Benefits and outcomes of LSS	223
Figure 7.4 Scree Plot.....	227
Figure 7.5 Hypothesized Mediation Model	234
Figure 7.6 Final Mediation Model.....	237
Figure 9.1 Theoretical Model of LSS implementation in EDs.....	257

LIST OF TABLES

Table 4.1 Key Concepts & Search Terms.....	66
Table 4.2 Final results per platform/database.....	67
Table 4.3 Summary of Studies using Lean.....	81
Table 4.4 A summary of studies using Six Sigma.....	87
Table 4.5 A summary of studies using Lean Six Sigma.....	90
Table 5.1 Conducted studies about CSFs for LSS implementations.....	122
Table 5.2 Publications on CSFs for LSS implementation in healthcare.....	127
Table 5.3 Comparison of ranks and importance factors of CSFs.....	130
Table 5.4 The most importance ten CSFs and ranks.....	132
Table 6.1 Participants profile.....	167
Table 6.2 Categories and sub-categories of open coding.....	170
Table 6.3 Definition of each category.....	171
Table 6.4 Coding process example.....	177
Table 7.1 CSFs of LSS implementation.....	211
Table 7.2 Participnt demographic information.....	217
Table 7.3 Descriptive statistics.....	224
Table 7.4 Descriptive statistics for elements of work environment.....	225
Table 7.5 KMO and Bartlett's Test.....	226
Table 7.6 Variance in EFA.....	226
Table 7.7 Component Matrix.....	227
Table 7.8 Reliability statistics if item deleted.....	228

Table 7.9 Correlation test results	230
Table 7.10 Coefficients Table for the Multiple Linear Regression	236

CHAPTER 1: INTRODUCTION

Healthcare is a complicated sector that faces many challenges including increased expenditures and difficulties related to individual or community access to appropriate care (Allaudeen, 2017). Such problems affect the healthcare systems of numerous countries such as the United States, the United Kingdom, Ireland, Egypt, and Saudi Arabia. This has led some governments to take academic and political action to classify and assess these issues (Albar, 2017; Allaudeen et al., 2017; Hussein et al., 2017; Laureani, 2012; McAlister et al., 2014).

Emergency departments (EDs) are important units within health care organizations for their essential role in providing urgent medical services to patients. As the demand for ED services increases, the patient length of stay (LOS) will strongly increase and result in unsatisfied patients and lower quality of care (Albar, 2016; Hussein, 2017). The Institute of Medicine (IOM) also reported on emergency care in the United States, emphasizing the looming crisis in the area and highlighting overcrowding as a major contributing issue (IOM, 2006). Another report published by the United States Government Accountability Office stated that “emergency departments crowding continues to occur, and some patients wait longer than recommended time frames” (GAO, 2009). To cope with this issue, multiple efforts have been concentrated on reaching an agreement on a definition for the problem, developing measures to address ED crowding, and studying its impact on ED clinical and operational outcomes (Albar, 2016; Furterer, 2018; Mandahawi et al., 2017).

Hussein et al. (2017) defined ED overcrowding as “an extreme excess of patients in the treatment areas, exceeding ED capacity and frequently necessitating medical care to be provided

in ED hallways and other makeshift examination areas” (p. 1). EDs are commonly known as a stressful environment, which is complicated by the increasing number of demands resulting in high-volume workload and high pressure (Johnston et al., 2016; Raziq et al., 2015). ED working environments are affected by many factors such as staff burnout, interpersonal conflicts, lower morale, job dissatisfaction, disempowerment, limited recognition of quality work, lack of staff training, motivation issues, and difficulties with retention and recruitment (Flowerdew et al., 2012; Johnston et al., 2016; Lambrou et al., 2010). Working in high-pressure environments with high demand for clinical skills can negatively affect staff morale (Escribà-Agüir et al., 2006; Johnston, 2016; Ross-Adjie et al., 2007). Therefore, the outcomes of staff stress include resignation, sick leave, and high turnover (Escribà-Agüir et al., 2006; Johnston, 2016). In a poor work environment, the probability of medical errors and long patient waiting times is high (Johnston, 2016; Laureani et al., 2013). There is a lack of investigation of in ED, which is a special work environment more likely to be affected by this issue. Work environment has become an essential factor in improving the healthcare services, shown in many studies to be associated with positive outcomes for organizations, workers, and patients (Weinberg et al., 2012). Therefore, this study investigates the impact of six elements of WE on successful implementation of LSS in ED, which are often more dynamic and complex than other areas of healthcare.

In the ED, the working environment has been defined by several studies. Johnston et al. (2016) indicated that this environment includes factors affecting the professional context in which ED staff work. Staff motivation is a necessary element in a health care system and plays a significant role in an organization’s ability to face many challenges (Lambrou et al., 2010). The ED is a stressful place to work. Multiple factors affect staff job satisfaction; for instance, studies

of ED staff perceptions indicate overload based on the increase in the number of patients, staff shortages, and budgetary cuts (Ajeigbe et al., 2013; Johnston et al., 2016).

Thus, in this doctoral research the author utilizes a mixed-methods approach to investigate how Lean Six Sigma (LSS) can be effectively implemented to improve the ED as well as to explore the impact of work environment on achievement of outcomes. The main objectives of this study are to 1) comprehensively synthesize the existing literature using a systematic literature review (SLR); 2) develop an Initial Conceptual Framework from existing evidence; and 3) conduct an Expert Study using a grounded-theory (GT) approach and 4) develop/execute a questionnaire survey to empirically refine and test the theoretical model. The remaining part of this chapter presents the research problem statement in addition to the research gap, purpose, questions, and contribution. Chapter 2 presents the background, followed by Chapter 3, which describes the research methodology. Chapter 4 provides the results of the SLR that was conducted and Chapter 5 presents a conceptual framework for critical success factors (CSFs) of LSS in EDs that was developed. Chapter 6 describes the theoretical model of LSS implementation in EDs developed from the GT results (Round 1 of the Expert Study) and then Chapter 7 illustrates the impact of the work environment on LSS implementation (Round 2 of the Expert Study). Chapter 8 provides a discussion of the overall study results and, finally, Chapter 9 concludes this document by presenting a summary of results and directions for future work.

1.1 Problem Statement

The rise in the number of ED patient visits and the requirement for staff to work with limited resources are causing overcrowding and consequently extending patients' length of stay,

which ultimately leads to lower overall health outcomes (Loubnan, 2018). According to the American Hospital Association (AHA) annual survey in 2016, patient ED visits in the United States exceeded 140 million that year. When demand outstrips supply, overcrowding and increased patient LOS result. Hussein et al. (2017) stated that “the number of emergency visits exceeds the ED’s capacity 35% of the time, resulting in overcrowding and congestion” (p. 6). This massive demand on services means that EDs frequently operate over capacity, which sometimes necessitates that medical care be provided in hallways. Many healthcare organizations assert that quality improvement methods have been successfully applied to healthcare processes, healthcare, and health. With the proper implementation of quality improvement methods, healthcare organizations can achieve and sustain substantial improvements (Provost, 2018).

Quality management and the implementation of LSS are applied by health care organizations to reduce costs, improve customer satisfaction, and increase effectiveness and efficiency, as well as to provide high-quality service delivery (Furterer, 2018; Laureani, 2010). Application of LSS within the ED allows health care organizations to attain a high level of quality and achieve patient satisfaction (Hilton et al., 2008; Laureani & Antony, 2012). Additionally, LSS can reduce waste and variability by creating better processes, reducing errors, increasing patient satisfaction rates, improving patient care, and nurturing a more productive and satisfied staff. To achieve these goals, “define, measure, analyze, improve, and control” (DMAIC) must be implemented to underpin LSS because it is a problem-solving tool that can be applied repeatedly to many process problems (Freitas & Costa, 2016; Jansson, 2017; Loubnan, 2018).

1.2 Research Gap

Researchers who have implemented process improvement tools such as LSS to achieve the desired outcomes often use DMAIC as a core methodology (Furterer, 2018; Kahl, 2005; Loubnan, 2018). These studies focused on implementing DMAIC as a process to improve outcomes from different processes in the EDs, such as waiting time (Furterer, 2018; Johnston et al., 2004), laboratory (Blick, 2013), Inventory (Tetty et al., 2016), patient flow (Furterer, 2018; Laureani et al., 2013), by centering on the overall process of the ED as well as the process flow of patients. Although these papers provide important insights into the use of these tools in ED, their authors only consider the patients' point of view instead of the ED employees' perspectives. The elements of ED work environment, including staff motivation, staff training, job satisfaction, teamwork, communication, and staff engagement, is studied far less often when using LSS in practice, creating an important opportunity to bridge the gap by investigating how work environment impacts the implementation of LSS. Therefore, this study is focused on identifying the critical success factors of LSS implementation in the ED. Furthermore, this study will consider staff perspectives and investigate the effect of work environment on the achievement of outcomes of LSS project.

Figure 1.1 provides a visual illustration of the research purpose in terms of how various factors lead to successful implementation of LSS and achievement of positive outcomes.

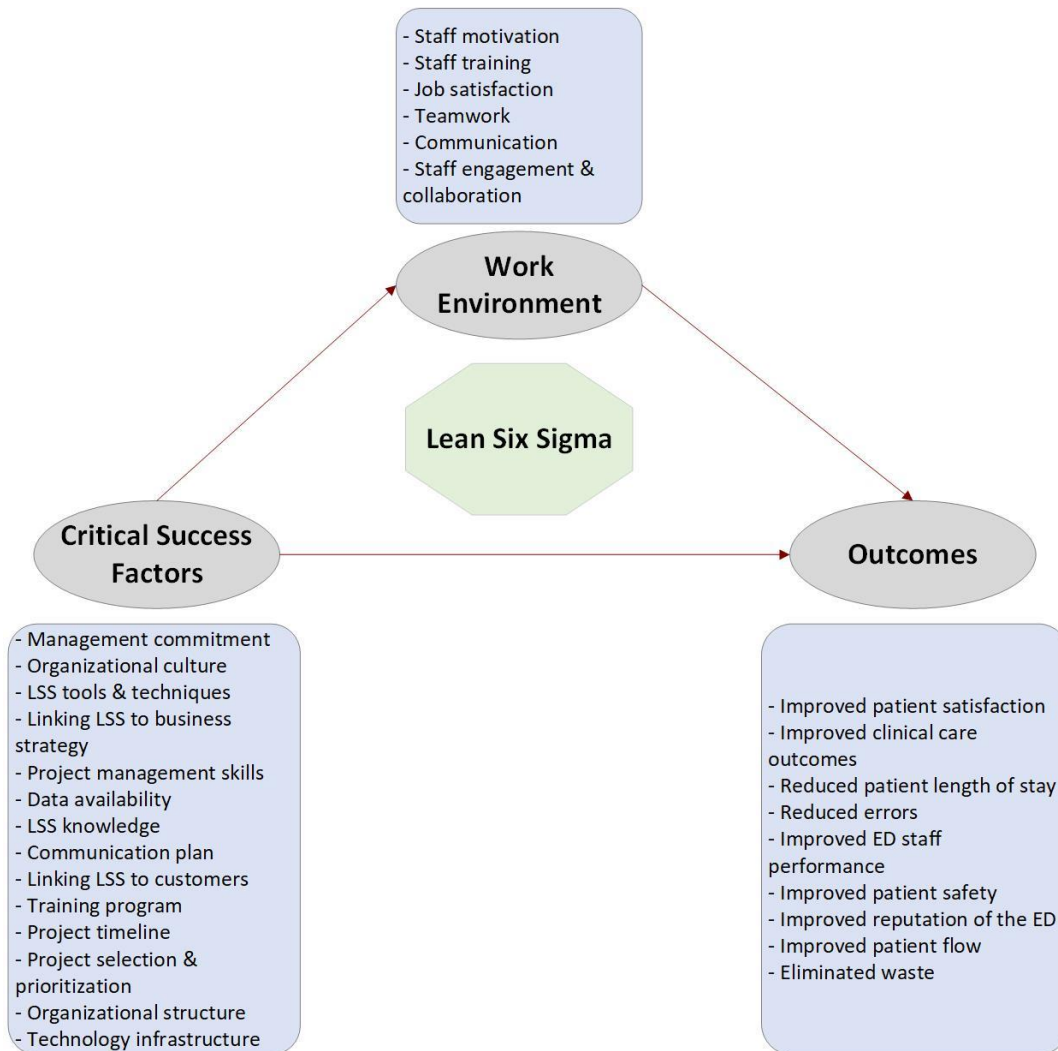


Figure 1.1 Guiding Conceptual Framework

This figure shows the three main concepts central to this study, which consists of critical success factors of LSS implementation, achievement of outcomes, and the elements of ED work environment. The ten most critical success factors were synthesized from the literature (Ahmed et al., 2018; Hilton et al., 2008; Laureani & Antony, 2012; Manville et al., 2012; Mishra, 2018; Zhang et al., 2016). The Expert Study focused on further exploring the critical success factors and

elements of work environment (Flowerdew et al., 2012; Johnston et al., 2016; Lambrou et al., 2010) as well as investigating the associated achievement of outcomes (Furterer 2018; Hitti et al., 2017; Laureani et al., 2013; Loubnan, 2018; Tettey et al., 2016; Wang et al., 2015).

1.3 Research Purpose

This research consists of one overarching question followed by several sub-questions (Creswell, 2007). The overarching research question defined for this study is: *How does work environment affect the successful implementation of Lean Six Sigma?* In addition, the following sub-questions were defined to guide this study:

Q1: What are the critical factors that affect LSS implementation success in ED?

Q2: What are the underlying dimensions of work environment?

Q3: How does ED work environment affect LSS implementation success?

(a): What is the strength of association between the elements of work environment and the overall success of LSS projects?

(b): What is the strength of association between the elements of work environment and the achievement of outcomes of LSS?

(c): What is the strength of association between the elements of work environment and the sustainability of outcomes?

Q4: Is the relationship between LSS factors and the achievement of outcomes mediated by the elements of work environment?

1.4 Research Objectives

The main purpose of the study is to explore the effect of work environment on the use of LSS in EDs. To achieve this goal, four main objectives were defined for this study:

1. Conduct a SLR and bibliometric analysis. to comprehensively synthesize the existing evidence in the literature and investigate trends in the research area.
2. Develop an Initial Conceptual Framework of critical success factors that affect LSS implementation in EDs that is grounded in evidence available in the literature.
3. Develop a theoretical model of LSS implementation in EDs using a grounded theory approach with subject-area experts.
4. Investigate the relationships between the elements of work environment and the successful use of LSS projects in ED; specifically, the achievement and sustainability of outcomes.

These objectives will support the development of a guiding framework that can be used to develop strategies to ensure the success of LSS projects in EDs.

1.5 Research Contribution Summary

This research makes several significant academic and professional contributions creating new knowledge that builds on the previously available evidence by doing innovative and exploratory research. The main contribution of this study is defining, operationalizing, and empirically investigating the importance of elements of work environment in ensuring the success of LSS projects. Further, the results of this study expand the current knowledge of operational improvement in emergency departments through the implementation of LSS. This research makes

several additional contributions to academic work by developing models of LSS implementation success in ED that are grounded in the literature and in expert experience. The study contributes to the verification of these existing theories of LSS success by synthesizing the list of the critical success factors of LSS implementation in ED from both the available literature and subject-area experts. The results of these studies are also used to create a multi-item construct for work environment to be added to the existing theoretical model of factors that affect LSS success. The theoretical models developed can be considered as an extension of existing knowledge of LSS implementation in the ED. The key focus of the research is to improve the chances of success for LSS projects to bring the potential benefits, such as improved patient safety and health outcomes, to emergency care.

The outcomes of this study are also relevant for industry professionals who using LSS in ED and suggest that addressing the common CSFs of LSS implementation may not be sufficient in a critical environment such as the ED. In the ED, professionals should focus on monitoring and improving the workplace environment to ensure success. The results provide insight into how work environment conditions function as components of the critical success factors needed to successfully implement LSS in emergency departments. The results of this study emphasize the need to prioritize various elements of work environment to meet the specific needs of each emergency department. Furthermore, the final conceptual model is also expected to contribute directly to how leaders of emergency departments set goals for LSS. As the health dynamics and needs of patients evolve, the overall approach to Lean Six Sigma is also expected to change so that it meets increasing standards and expectations in healthcare delivery.

Overall, the research makes significant academic and professional contributions. Through the research, it is possible to establish new models and knowledge necessary for implementing LSS in the ED. The study also supports assertions that LSS can improve patient safety and other related outcomes in the ED. The research also shows how organizational leaders can use the LSS to set goals for ED and enhance service delivery. By addressing the ED, WE, leaders can bring the full intended benefits of LSS to their departments.

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CHAPTER 2: BACKGROUND

In the 1950s, the ED was simply a hospital room reserved for emergency cases (Kellermann et al., 2013). However, in 1961 small groups of medical professionals put themselves forward to specialize in emergency care (Zink, 2006). In 1968, some of these specialists worked together to establish the American College of Emergency Physicians (ACEP) and, in 1970, the first emergency medicine residency program was established (Zink, 2006). During that time, the number of emergency care specialists increased, which transformed hospital emergency rooms into full departments that were qualified to manage a wide range of urgent care services (Kellermann et al., 2013).

In 2006, the IOM focused on the topic of emergency care for the first time and published three reports the following year in which it studied the roles of emergency medical services, emergency care, and pediatric care (IOM, 2007). Despite the remarkable progress in emergency care research, technical capability, and training, the IOM committee expressed concern that increasingly growing demand and declining financial support for emergency care were jeopardizing these accomplishments. The IOM committee stated that emergency care in hospital was “at the breaking point” (IOM, 2007).

As shown in Figure 2.1, which demonstrates that ED conditions continue to worsen, the number of emergency visits in 2016 increased to a record high of 136.3 million (AHA, 2016). This is a 50.6% increase from 94.7 million patient visits in 1995. According to the ACEP, the

implementation of the Affordable Care Act, which is a comprehensive health care reform law ordained in 2010, caused this increase (AHA, 2016).

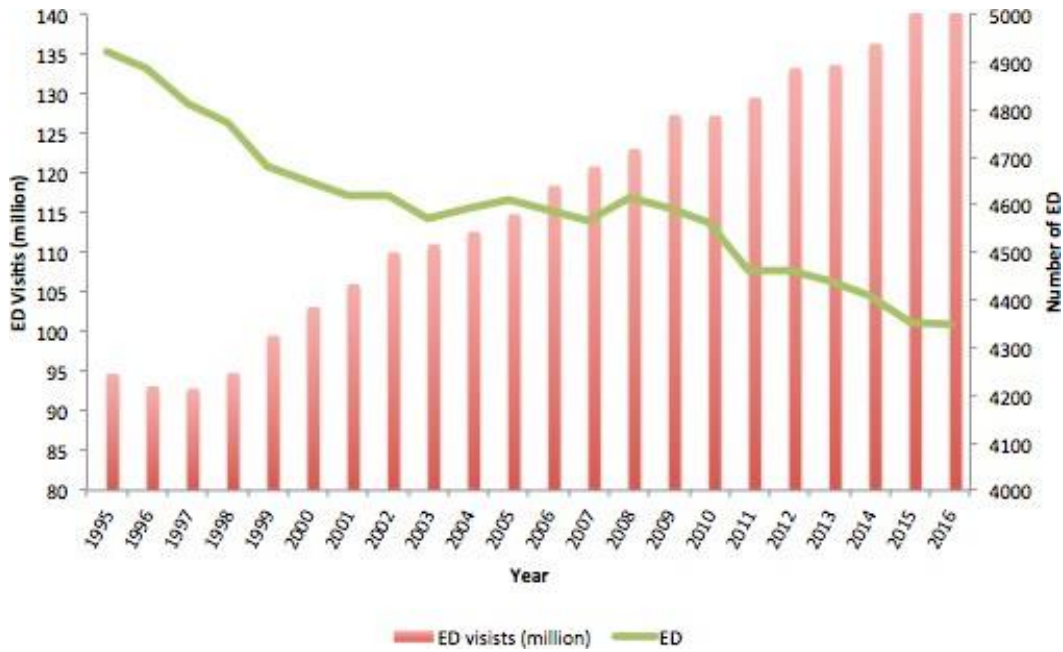


Figure 2.1 Number of EDs and ED visits in the United States, 1995-2016

Source: American Hospital Association (2016)

Figure 2.1 also shows the number of EDs, which decreased by 12.5% from 1995 to 2016 (AHA, 2016). The reason for this fall is that, as Rabin (2011) mentioned, “Emergency departments were most likely to have closed if they served large numbers of the poor, were at commercially operated hospitals, were in hospitals with skimpy profit margins or operated in highly competitive markets.” The decreased number of EDs, together with the increased number of ED visits, shows the high demand for service, which is strongly associated with overcrowding and further increases patient LOS.

Lardieri (2018) indicated certain outcomes that are related to the increased number of ED visits including convenience, cost, and long wait time. Additionally, Figure 2.2 illustrates that ED visits per 1,000 people increased from 360 to 441 between 1995 and 2016, which points to a growing demand for emergency care in the ED.

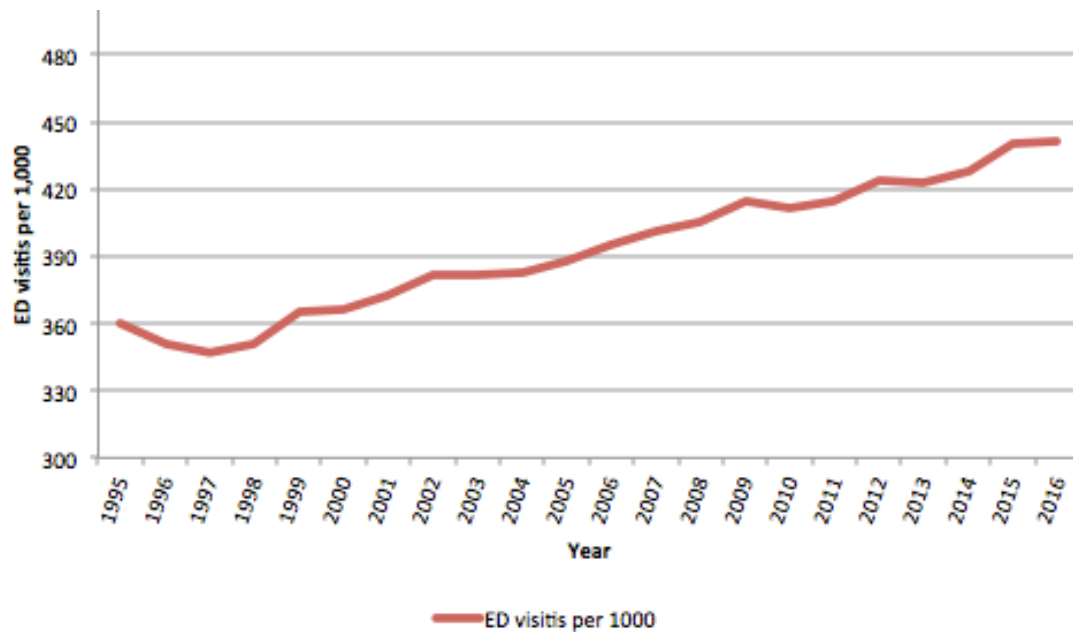


Figure 2.2: Number of ED visits per 1,000 patients in the United States, 1995-2016

Source: American Hospital Association (2016)

Increased patient volume is an essential factor that causes overcrowding in ED. Several reasons have been suggested for the increased patient volume in EDs, including nursing shortages, lengthy emergency evaluations, higher patient acuity, reduced bed capacity, and difficulties related to connecting patients to specialists (Furterer, 2018). The IOM's (1999) report "Crossing the Quality Chasm" stated that the health care system in the United States faces serious problems. To redesign the American health care system, the IOM (1999) set out six goals for improvement as follows:

- Patient-centeredness: listening to, involving, and informing patients as regards their care as well as taking into account their values and needs.
- Safety: avoiding causing harm through health care.
- Equity: providing high-quality care to patients regardless of their characteristics and ethnicity.
- Effectiveness: health care must match science, with neither overuse nor underuse of the best available technique.
- Efficient: reducing waste and the cost of equipment, time, idea, capital, and supplies.
- Timeliness: decreasing waiting time (LOS) for patients.

According to Pozgar (2013), the U.S. Congress noticed the importance of making improvements to quality of health care based on increased medical errors, leading to the enactment of the Healthcare Quality Improvement Act of 1986. Everhart (2017) emphasized that numerous patients died each year as a result of the poor quality of provided care services as well as a lack of safety. Elg et al. (2013) noted that health care professionals have attempted to use process improvement tools in real life to monitor the change, improve the process, enhance quality and efficiency of care services, expedite the patient flow, and increase patient satisfaction in provision of health care services.

2.1 Implementation of Process and Quality Improvement Tools

The implementation of quality improvement (QI) tools provides practical strategies to improve operational performance and establish competitive advantages (Deniz, 2017; Hussein, 2017; Liberator, 2012). Tools and approaches such as total quality management, critical to quality, Six Sigma, Lean, and LSS have been successfully applied in manufacturing and service industries to improve value for money, improve systems, address the cause of defects, reduce variability, and

lower costs (Boak et al., 2017; Hwang et al., 2014; Padhy, 2017; Wang et al., 2012). Decades ago, health care organizations also began using process improvements to survive their competitive and dynamic market (Padhy, 2017; Wang et al., 2012). However, many health care organizations face significant challenges when implementing these tools due to their unique operation conditions.

Many leaders make use of LSS as a primary tool to support their improvement strategy (Knapp, 2015). Business administrators and managers from diverse companies have reported the significant benefits of Lean Six Sigma (Knapp, 2015). Some of the companies, such as 3M, Amazon, Atos, Autoliv, BAE Systems, and Bank of America, can offer support to others when using it. These corporations know that this LSS method focuses on reducing waste and improving process. Of course, the implementation of LSS generates some broader applications in various work environments (Yadav, Seth, & Desai, 2018).

Although there are many claims of the effectiveness of these tools (Hwang et al., 2014; Mazzocato et al., 2010), some analysts have argued that healthcare sector is considerably slower in embracing QI tools than the manufacturing sector (Furterer & Elshennawy, 2005; McIntosh et al., 2014). The implementation of LSS has not been without challenges and barriers, especially with services sectors (Antony et al., 2007; Chakrabarty & Tan, 2007; Matchette, 2006; Rylander & Provost, 2006). Hensley and Dobie (2005) identify some of the challenges in applying QI tools in the service sector, including difficulties in collecting data, lack of reliable data, difficulty measuring the process due to various things that happen when customers and service providers interact, and difficulty in controlling and measuring QI tools due to the difficulties that arise from the complex and dynamic operating processes. In addition, the costs of implementing QI tools in an organization can be considerably high due to the high training costs (Antony, 2006; Fahmy,

2006). These reasons have prevented some service organizations from implementing QI tools (Antony, 2006; Fahmy, 2006).

The LSS methodology is more comprehensive than the other improvement approaches such as Continuous Quality Improvement and Total Quality Management. LSS allows businesses to attain sustainable improvements, leading to the attainment of objectives while also enabling environmental sustainability through the reduction of waste (Boak et al., 2017; Padhy, 2017; Wang et al., 2012). LSS contributes to enterprise success and is mainly popular among large healthcare companies because it provides both set of tools and a methodology that allow them to influence output, quality, and finances, enabling the company to strengthen itself in the market, thus obtaining competitive advantage (Hussein, 2017; Loubnan, 2018). However, the realization of the intended results is not always easy. Without addressing key success factors, such as project purpose, adequate training of employees, communication, teamwork, staff motivation, statistics, and black belts, success cannot be realized. According to (Hayes 2018), alignment is a crucial determiner of success attainment. Due to this, LSS relies on objective and robust leadership to manage and sustain the project. All persons within the organization need to understand the management effort and remain committed to enhancing teamwork in the project in order to attain success (Boak et al., 2017; Deniz, 2017; Loubnan, 2018). Overall, the successful integration of lean principles and six sigma in controlling organizational activities depends on the organization's leadership and culture (Loubnan, 2018) and, when implemented successfully, applications in the company's decision-making process has been shown to increase the company's success (Deniz, 2017; Hussein, 2017; Loubnan, 2018).

2.2 Lean Six Sigma in Practice

LSS is a continuous improvement approach that includes the integration of principles and tools from both six sigma and lean. LSS is focused on improving customer satisfaction, speed, and quality while reducing process variation and defects (Laureani et al., 2013; Yadav Desai, 2016). Sreedharan and Raju (2016) listed a compilation of LSS definitions from various literature, categorized by different authors and themes such as methodology, system, model, and approach. This approach has been used successfully in both manufacturing organizations and health care organizations to improve their competitiveness, effectiveness, and efficiency (Prashant & Sandeep, 2017). The LSS methodology has well-studied principles in health care owing to its efficacy for reducing medical errors and its zero-tolerance approach to mistakes (Alcaide-Muñoz & Gutierrez-Gutierrez, 2017; Laureani et al., 2013).

Numerous health care organizations have implemented LSS projects (Antony et al., 2006). Generally, the objective has been to improve measures such as safety, efficiency, quality, and customer satisfaction; to identify and eliminate waste; to improve clinical processes; and to support staff in assessing their workplaces (Antony et al., 2006). Many organizations have applied the DMAIC process and distinguished it from other QI tools for its robust framework that allows teams achieve long-term, stable, and standard work (Jansson, 2017). The observed advantages indicated an increase in cost savings, a decrease in defects (errors), and an improvement in customer satisfaction (Chugani et al., 2017; Garza-Reyes, 2015; Kahl, 2005). The DMAIC achievement now extends beyond the cost-saving objective to improve the quality of the health care industry, with a focus on patient safety (Kahl, 2005).

Process improvement approaches such as six sigma and lean are being applied to make necessary changes in health care. Additionally, both methodologies are now commonly invoked in manufacturing and service areas (Laureani, 2012; Prashant & Sandeep, 2017). Case studies in the service sector include the health care delivery services industry (Deniz, 2017; Leone & Rahn, 2010) and HR administration (Syahputri, 2018). Some case studies of implementing Lean Six Sigma in the manufacturing industry can be found, such as welding wires (Hassan, 2013) and litchi juice production plants in the foods and beverages industry in Bangladesh (Hossain, 2015). The authors of all these studies used both six sigma and lean successfully and achieved good outcomes and benefits, including reducing waste, improving quality, regulating cost, and increasing customer satisfaction. Hence, an attempt should be made to adopt such a tool successfully to allow the ED to capture the same benefits.

2.3 Critical Success Factors of LSS Implementation

Several studies available in the literature have identified critical success factors for the implementation of LSS in emergency departments. Hitti et al. (2017) mentioned that the integration of any successful QI initiative, such as LSS requires the involvement, commitment and leadership of top management. Management involvement, commitment and leadership is also identified by Al Owad et al (2014) as an important concept in emergency departments in the sense that it acts as a catalyst in enhancing the performance of other key factors including total quality management practices. A great number of managers, including Jack Welch of General Electricals, who have adopted this critical success factor were able to successfully restructure their business and influence a positive attitude among the employees (Setijono et al, 2012). To ensure the

successful implementation of LSS in healthcare and emergency departments, Timmons et al (2014) asserted that it is also important that there is effective change in the culture of the department. Their research suggests that successful implementation of LSS can be achieved through concerted effort by management with the aim of getting involved with health workers within the department, continuous improvement and cooperation.

Another critical success factor for the successful implementation of LSS is training and understanding of the principles behind the methodology of Six Sigma. In the implementation of organizational changes, Arthur (2011) argued that employee training is key among the component of workforce management. Thus, if workforce management can be effective in transforming employees into creative problem solvers, there is the need for training. According to Furterer (2018), training in relation to quality issues should stress on the methodologies for effective communication, understanding and control in statistical process and problem solving. Isfahani et al (2019) added that training of health workers should emphasize leadership techniques, process improvement, and team techniques. They stressed that the understanding and control of statistical tools such as design of experiments, regression analysis, analysis of variance and control of statistic process is key in solving problems.

The selection and prioritization of project is identified by several research findings as important tool needed for the successful implementation of Six Sigma (Aguezzoul & Nyongue, 2012). This means that ineffective selection of a project by management can result in dalliance in outcomes which can cause a great deal of frustration. However, the ability of project managers to demonstrate this fundamental skill in project management is key to the successful implementation of Lean Six Sigma. Al Owad et al (2014) stated that Lean Six Sigma as a strategy is classified as

a project driven-basis and for that matter it is important to improve upon project management skills in order to meet the expectations of patients during the course of the project. In another study, Aguezzoul & Nyongue (2012) mentioned that linking six sigma to patients provides additional basis for the success implementation of the project. According to them, the determination of the needs, expectations and requirements of patients should form the basis of projects. Some of these factors are considered as an elements of work environment such as training, communication, and commitment, which drive the LSS projects to be more effective.

Finally, some researchers have identified different elements of the work environment to be important such as motivation and job satisfaction. However, most studies do not consider the work environment. This is a significant gap in the research as ED tend to be dynamic and complex work environments and this factor is likely to have a strong influence for successful use of LSS.

2.4 Work Environment

Nantsupawat et al (2017) views work environment as an entity which defines the overall actions and other influential forces and factors that have the potential to contend with the performance and activities of employees. For Aronsson et al (2017) and Olson (2018), work environment is comprised of three key sub-environments; namely, the human environment, organizational environment, and technical environment. The human environment defines people whom employees identify themselves with, the leadership, interactional issues and teamwork. Organizational environment defines the procedures, values, practices, philosophy and systems which influences the productivity of employees (Olson, 2018). The technical environment defines the tools, equipment, infrastructure and other technical elements that enables employees to perform

their duties. Numerous studies have identified that the understanding of the impact of work environment is key to the overall performance of workers (Yusuf & Bit-Lian, 2020; Sutha, 2020). Thus, work environment can positively or negatively impact the job performance of workers. A good work environment will enhance productivity, increase willingness to work and strengthen work ethics with limited chances of committing errors. Likewise, a poor work environment will produce otherwise.

According to Nantsupawat et al (2017), work environment is identified to contribute to the successful implementation of LSS. They stressed on the methodology of LSS used in reducing the amount of waste while increasing efficiency and quality of project outcomes. Yusuf & Bit-Lian (2020) found a successful implementation of Six Sigma in a good work environment in emergency departments enhances the movement of patients in the emergency department. Further, Sutha (2020) added that successful implementation of LSS in an organization with a strong work environment has the potential of reducing waste, waiting time, processing time and errors but instead enhance productivity. Aronsson et al (2017) after finding associated benefits of LSS to work environment concluded in their research that the combination of the two has the potential of improving compliance with the effluent regulations in emergency departments. Although WE has been shown to be important in the success of LSS in other environments, this has not been studied in the context of ED. However, ED tend to have unique WE suggesting that this variable may be critical in successfully using LSS in ED.

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CHAPTER 3: RESEARCH METHODOLOGY

Research design provides the overall structure that the researcher will follow, the type of data the researcher will collect to investigate the problem, the reasonable means of interpreting those data, and the data analysis the researcher will conduct (Leedy & Ormrod, 2014). As stated by Arbner and Bjerke (1997), “the design of the research should be carefully planned to yield results that are as objective as possible. Analysis of the data should be sufficient to reveal its significance; the analysis techniques used should be appropriate” (p. 256).

The nature of this research is to explore the Lean Six Sigma (LSS) implementation process and develop a conceptual framework to facilitate extending the scope of LSS implementation in the emergency department (ED) while considering the effects of the working environment (WE). This mixed-methods study is centered on a GT approach, which is a qualitative and systematic technique for developing a tangible theory from collected data (Chen, 2005). The importance of this perspective in GT is addressed by defining essential questions in different aspects of process improvements such as LSS and process management. This study consists of four phases: research framing, conceptual framework development, model formulation, and model development and testing, as shown in Figure 3.1.

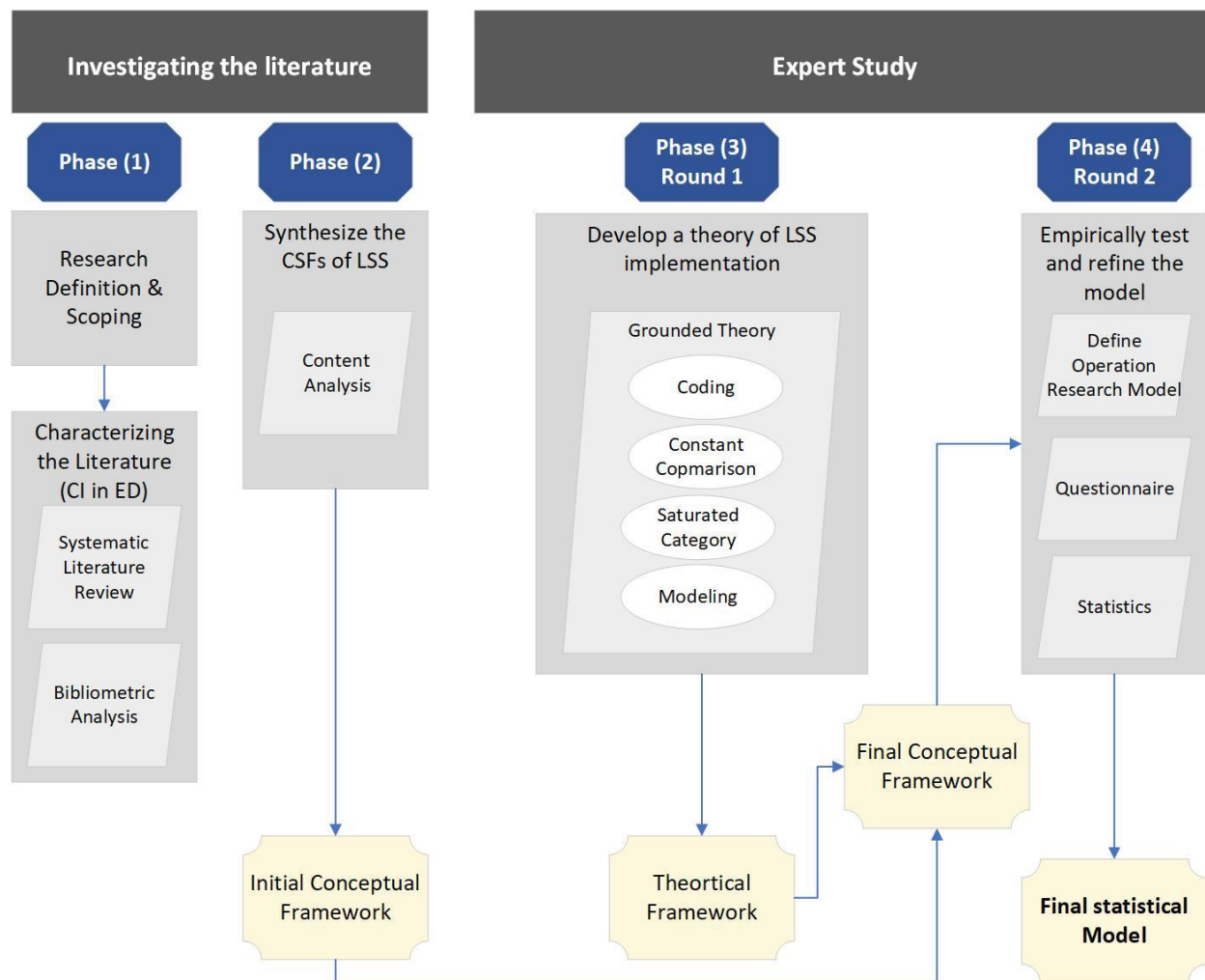


Figure 3.1: Research design overview

- 1- **Phase One:** In this phase, a comprehensive literature review, which illustrates background and research developments related to the research questions as well as an evaluation of the maturity of this field, is conducted to evaluate how QI tools have been used in EDs. Conducting a literature review and analyzing the results in a systematic manner helps to identify an overall view of the current state of this research area as well as providing an indication of the scope of work undertaken and current knowledge in the field.

- 2- **Phase Two:** This phase is an inductive synthesis of existing evidence to create a model of CSF for LSS success in ED that is grounded in the literature. This phase consisted of evaluating papers identified by a second literature review to develop an Initial Conceptual Framework of critical success factors of LSS implementation in ED using a Content Analysis approach. The initial conceptual model developed represents an initial theoretical understanding of the problem and includes a list of potential variables and outcomes of the application of LSS projects and how these variables and outcomes are defined. Once the current knowledge from the literature was synthesized and a complete list of factors was defined and ranked in terms of importance, the results were used to develop an initial conceptual model to guide the empirical portion of this research.
- 3- **Phase Three:** This phase aimed to conduct empirical research to investigate expert experiences related to implementing LSS in EDs. A two-phase expert study was conducted to conduct an inductive mixed-methods study of LSS implementation in ED. Phase 3 consisted of Round 1 of the expert study, which collected qualitative data via an open-ended questionnaire and applied a GT approach to develop the theoretical model.
- 4- **Phase Four:** This phase leveraged the findings from the previous phases to develop the final conceptual model, which was then operationalized and tested using an online survey questionnaire and statistical analyses. An exploratory Factor Analysis (EFA) was applied to determine the underlying structure of work environment factors in LSS projects. In addition, a bivariate correlation was used to investigate the relationships between the elements of work environment and the successful LSS projects. Finally, a mediation analysis was conducted to investigate the potential mediating effect of WE.

This research consists of a mixed-methods, empirical study starting with a comprehensive review of the literature to investigate recent advancements in CI in ED followed by a Content Analysis study to inductively synthesize available evidence and as well as guiding the development of an LSS implementation framework for ED settings. This synthesized information was then used to investigate and identify the importance of the factors and their interrelationships using an expert study and GT technique. The expert study focused on investigating the experience and knowledge of subject-area experts, including both academic researchers and industry professionals, regarding LSS implementations in ED. GT was then used to develop a theoretical model of the critical success factors to support LSS implementation efforts in EDs. An operational research model was then developed and tested using an online survey questionnaire focused on experiences when implementing LSS in ED. This study also considered the relationship between elements of work environment and the successful completion of LSS projects as well as determining the underlying structure of work environment factors. Further, this study develops a construct for work environment that can be used for assessing this factor in future studies and investigates the role of work environment in ensuring LSS success. Finally, statistical models are created to empirically investigate the relationship of WE to both the CSFs and LSS success in ED.

3.1 Research Framing

Conducting a literature review at the early stages of the study is an important step to determine if the planned study has been carried out before, identify the gap, and define the scope. It will also enable a synthesis of previously published empirical evidence for developing the

conceptual framework and provide evidence to compare to the expert testimony during the GT study. Such a literature review will also support the interest for the particular research area. The SLR approach to be used in this research allows a highly sensitive search strategy based on finding as many of the existing publications as possible while remaining feasible in terms of the number of search results (Tranfield et al., 2003). Therefore, the author conducted a comprehensive SLR as well as a bibliometric analysis of the results.

This SLR was conducted following the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2009). The SLR is a protocol in which a body of literature is collected, reviewed, and evaluated using predetermined and standardized strategies (Strukelj, 2018). In an SLR, the aim is to distinguish, fundamentally assess, and summarize the current evidence concerning a clearly defined issue. The technique of data collection, the rationale, and the hypothesis are prepared prior to the review to reduce bias (Moher et al., 2009; Strukelj, 2018). The procedure for this systematic review has been developed to reduce the probability that the review would be influenced by expectation. The process of executing a systematic review consists of six phases (Strukelj, 2018):

- 1- Define the objectives of the review clearly.
- 2- Define the methodology of the review and identify eligibility criteria.
- 3- Recover qualified literature and completely report the research strategy all through the process.
- 4- Evaluate the methodological quality of the selected literature and exclude the papers with low methodological quality.
- 5- Identify the needed papers from all the selected studies and summarize the findings.
- 6- Collect the results of different studies and write them in narrative form.

A search strategy was used for the review to find a comprehensive group of papers relevant to answering the identified research questions. The search strategy included defining the search scope and vetting the process used in identifying relevant studies (Kevin et al., 2018). The search strategy permitted the development of a replicable and open review of external literature (Kevin et al., 2018). Current academic literature in the field of continuous improvement tools for the ED, including journal articles, conference presentations and proceedings, textbooks, and dissertations/theses, were considered as key sources for this review owing to the nature of the concept of research area maturity, which is mainly relevant to the academic community. The results of this SLR are summarized in Chapter 4.

3.2 Conceptual Framework Development

LSS has become one of the most commonly used tools for QI in the health care sector (Klein et al., 2018; Leggat et al., 2016; Sperl, et al., 2013). Goals such as reducing process cycle time and decreasing process defects have been successfully achieved by applying such quality tools as LSS (Deniz, 2017; Dion, 2011; Liberator, 2012). This approach offers a means for health care organizations to improve the way they conduct their work as well as providing organizational advantages such as higher process quality, enhanced operational efficiency, better value for money, and improved cost-effectiveness (Laureani et al., 2013). In addition, LSS helps achieve good outcomes and benefits, which include reducing waste, improving quality, regulating cost, and increasing customer satisfaction.

The results of the Phase 2 literature review and Content Analysis (Muraliraj et al., 2017) show that 36 CSFs of LSS implementation in emergency departments are analyzed and compared

based on their ranks in seven papers. Additionally, the most important ten CSFs have been identified to develop a conceptual framework of CSFs of LSS implementation in the ED by using a Content Analysis. This approach inductively synthesizes an initial conceptual model from existing evidence to ensure that this work is grounded in the literature. The developed conceptual framework of CSFs of LSS implementation in EDs is summarized in Chapter 5.

3.3 Model Formulation

This phase follows the GT approach in that the aim is to develop a theoretical model of LSS implementation based on the experts' view in tandem with other seminal and empirical information (Creswell, 2007). This study is focused on successful implementation of LSS as well as the establishment of theoretical constructs that allow for measured predictability in behaviors. The development of a new theory of work environment provide important insights that are helpful for health care organization leaders when planning to improve processes by implementing LSS in an ED.

3.3.1 Expert Study

An expert study is a data collection approach centered on analyzing expertise from chosen experts regarding significant topics identified within the target domain of study. GT is a data analysis approach aimed at discovering an emerging theory; in addition, it is usually used for the purpose of framework development, forecasting, identifying prioritization, and issue identification (Okoli & Pawlowski, 2004). The objective of the research is to conduct an expert study that

includes using a survey questionnaire with GT to analyze qualitative data (Phase 3) and statistics to analyze quantitative data (Phase 4).

The expert study consists of two rounds (i.e., Phase 3 and Phase 4) using qualitative and quantitative online survey questionnaires. Round 1 of the Expert Study (Phase 3) was aimed at collecting qualitative data of the success factors, challenges, and outcomes of LSS implementation based on the experts' experience using LSS in ED. The experts were asked to provide any additional factors, challenges, and outcomes that are significant to the LSS implementation process on the significance of the success factors and outcomes and at identifying any additional factors or outcomes that are significant to the LSS implementation process. In addition, the experts were asked about the importance of the ED work environment and its relationship to the achievement of LSS outcomes. A range of open-ended questions were posed to the experts to gather evidence regarding the significance of this relationship to the success of the implementation process. The open-ended questions included two sections: demographic questions and questions about the observed factors during the implementation and perceptions of success. Open-ended questions allow participants to provide more information, such as attitudes, feelings, and their understanding of the subject (Weller et al., 2018). This is in contrast to closed-ended questions, which, because of the limitation and simplicity of the answers, may not offer the participants choices that reflect their real experiences (Weller et al., 2018). Additionally, open-ended questions give participants the opportunity to explain if they do not have an opinion on an issue or do not understand the question (Singer & Couper, 2017). Once the information was gathered, the GT approach was used to analyze the qualitative data to develop the theoretical model. At the end of this phase, the two

models developed from the Content Analysis results from Phase 2 and Round 1 of Expert Study results from Phase 3 were used to develop the final conceptual model as a basis for Phase 4.

Round 2 of the Expert Study (Phase 4) aimed to leverage the Final Conceptual Framework developed from previous phases to develop a construct for work environment and conduct a quantitative analysis of key relationships. This phase focused on investigating the relationship between elements of work environment and the different aspects of successful LSS projects. The quantitative survey was sent to all participants of Round 1 of the Expert Study (Phase 3) to allow them a chance to reflect on the final framework as well as to collect empirical evidence of the last LSS project that they participated in or observed. In order to increase the sample size and ensure an acceptable statistical power to develop the work environment construct; the survey was also sent to an extended sample of potential experts. The two samples were compared and the results showed that the two samples were appropriate to combine and, therefore, the combined sample was used to develop the final statistical models.

The survey was sent to experts using 5-point Likert scales (e.g., 1 = strongly agree, 2 = agree, 3 = neutral, 4 = disagree, 5 = strongly disagree). Likert scales are widely used to measure opinions and attitudes with a greater degree of nuance than can be achieved with simple Yes/No questions (McLeod, 2004). Additionally, Likert scales are used to gather empirical data, which is appropriate for statistics that will be used for estimating significance of relationships (Jamieson, 2004). Even-scale ratings force participants to choose a positive or negative response, with no room for neutral ratings. However, some argued that surveys should not lead participants to one answer or another. It should allow them to give their actual response, even if it is neutral (Jamieson,

2004). Meanwhile, an odd-scale rating allows for a statistical mid-point. It serves the dual purpose of eliminating the biased participants' feedback and providing more accuracy in the data analysis.

The known limitations of an expert study include the risk of measurement errors, which can result from the way the questionnaire has been developed and worded. The participants' biases and the low rate of responses could be other limitations of such a study. Because the expert study relies on experts' opinions and perspectives as rooted in their experience and knowledge, there may be viewpoints on the LSS implementation process that are not identified. The protocol was thoroughly pilot-tested to ensure that the data collection instruments were appropriate.

3.3.2 Grounded Theory

As stated earlier, GT was used to analyze the collected data from Round 1 of the Expert Study. Figure 3.2 provides a graphic representation of the four phases of the GT process (Paivarinta et al., 2016):

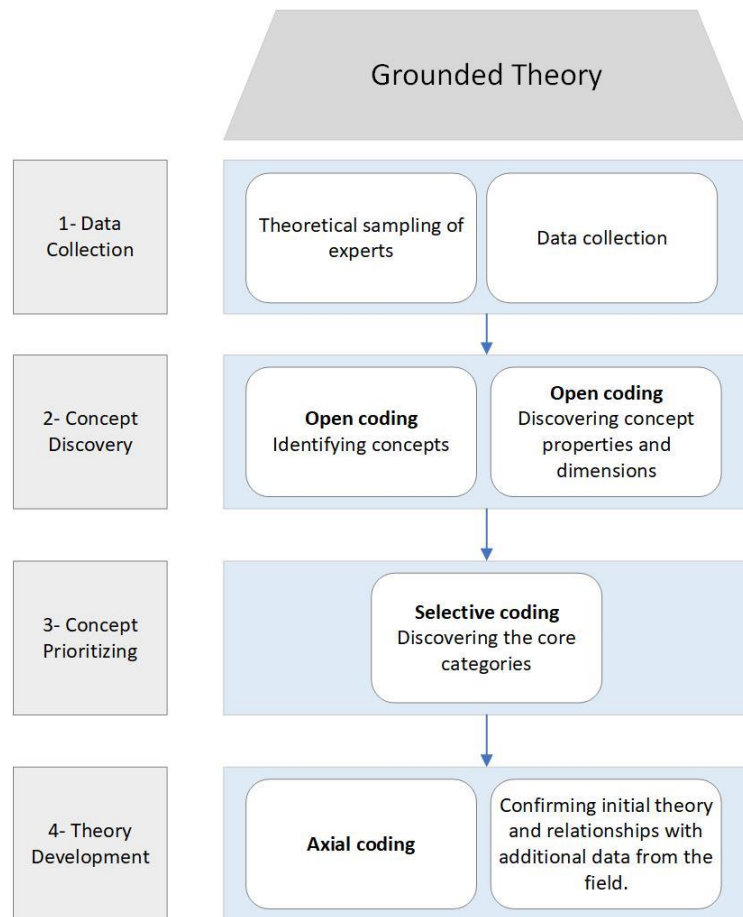


Figure 3.2: Grounded Theory Process

3.3.2.1 Data collection

The first step of the process is data collection. In qualitative research, data collection depends on four main types of sources: documents, observation, interviews, and audiovisual materials (Creswell, 2007). In this research plan, the method of asking open-ended questions via an online survey will be used to collect the needed data and information. In GT, the researcher relies heavily on personal preferences to analyze and interpret the collected data when selecting the core categories for theory building (Creswell, 2007). In addition, the GT researcher can select

and analyze new data during the research process. During the GT process, the data must be collected with no researcher bias. As stated by Creswell (2007), GT is derived from the study of a phenomenon as it is represented. As stated previously, Round 1 of the Expert Study (Phase 3) consisted of an online survey, which included a range of an open-ended questions regarding the factors, challenges, and outcomes of LSS implementation as well as the elements of work environment. The qualitative data were analyzed using GT coding and the results of this analysis were used as a foundation for the quantitative survey in Round 2 of the Expert Study (Phase 4).

Theoretical sampling

The technique of theoretical sampling is based on collecting, analyzing, and coding the data. As stated by Glaser and Strauss (1967), this process is a “continuously growing process” in which “each stage after a time is transformed into the next” and wherein “earlier stages do remain in operation simultaneously throughout the analysis and each provides continuous development to its successive stage until the analysis is terminated” (p. 105).

This research sought to discern the thoughts and opinions of experts in the field of interest through the questionnaire. The study samples of this research include industry experts who have directly participated in conducting a LSS project to improve an ED. In addition to these experts, academic experts who have published journal articles on applications of LSS in an ED were also canvassed. This process of gaining experience and knowledge from the chosen panel supports the base of knowledge. The sampling approach is highly important to the rigor of GT, which depends on accuracy in collecting data based on experts’ experience.

Additionally, the critical point in the sampling approach is to avoid information bias by accomplishing a state of systematic sampling, as well as obtaining responses that will help to develop a theory that is sound and unbiased. To supplement this sample of experts, additional potential participants were identified through relevant research communities, such as the *American Society for Quality (ASQ.org)*, the *American Society for Engineering Management (ASEM.org)*, and the *Quality Control & Reliability Engineering of the Institute of Industrial & System Engineering (IISE.org)*. Expert studies generally call for a minimum sample of 10–20 participants (Akins et al., 2005). This study consisted of a panel of 36 expert participants including both industry professionals and academic researchers.

Data analysis

Considering the process-based nature of the phenomenon of study, the data from Round 1 of the Expert Study were analyzed with a GT approach. GT involves three categories of coding: open coding, axial coding, and selective coding (Creswell, 2007). The three categories of coding are stepped approaches that end with a set of theoretical propositions (Creswell, 2007), which would include the research questions, literature review, and new insights. The propositions would also form the plan for data collection as well as strategies for relevant analysis (Stake, 1995). In addition, the inter-rater agreement exercises (Mackinnon, 2000) with a second, experienced coder was conducted during the coding phases to help reduce bias and develop the codes. The joint probability of agreement (Cohen, 1968) is used to measure agreement on the codes and code structure.

3.3.2.2 Concept Discovery

GT is aimed at forming abstract categories of concepts (Paivarinta et al., 2016). The concept of open coding, as stated by Strauss and Corbin (1998), is “the analytic process through which concepts are identified and their properties and dimensions are discovered in data” (p. 101). This phase focused on summarizing the results that emerge from the collected data and identifying a consolidated list of successful factors of implementing LSS. The open coding analysis process would create a list of categories or properties, by going through the data, which relate to each other through consequent axial coding. The properties provide more information about each category. In this study, the consolidated list included factors that affect the successful implementation of LSS in ED, as well as the elements of work environment.

3.3.2.3 Concept Prioritization

After the consolidated list is created, axial coding is applied, which relies on identifying the relationships between open coding concepts or properties and their dimensions (Strauss & Corbin, 1998). One open coding category should be selected and positioned as the core phenomenon; then, other categories are related to it. The selective coding includes identification of the core variable that includes all of the data. The analysis process of axial and selective coding would concentrate on the categories in the prioritized factors to construct more detailed theories and explanations. This process is repeated until the research reaches saturation, which is when further iterations do not result in any significant changes to the code definitions or structure. As mentioned earlier, inter-rater agreement exercise was conducted with two experienced coders. The initial agreement was 70% and the exercise was repeated refining the codes until a 90% agreement was achieved.

3.3.2.4 Theory Development

The results extracted from the previous phases—open and axial coding— gave a strong indication of the most essential factors related to the concept categories as well as the elements of work environment. The resulting theoretical model represents the initial theory that has been discussed in Chapter 6.

3.4 Model Development and Testing

This section describes the last phase of the research design, which focused on operationalizing and empirically testing the Final Conceptual Model using a field study consisting of a survey questionnaire. The Initial Conceptual Framework developed from the results of the Content Analysis was revised based on the results from Round 1 of the Expert Study to develop the Final Conceptual Framework of the successful implementation of LSS in EDs. The Final Conceptual Framework integrates the results from the Content Analysis and Round 1 of the Expert study to create a comprehensive guiding framework for Phase 4. The phases of developing the theory should be sequential because the study relies on acquiring the information from previous steps. The results of this phase produced the Final Conceptual Model of CSFs of LSS implementation as well as the elements of work environment. This phase of this research then focused on quantitatively developing the Final Statistical Model to determine the latent constructs of work environment factors in LSS implementation in EDs and to investigate the relationship between elements of WE and the different aspects of successful LSS projects.

3.4.1 Survey Questionnaire

The Final Conceptual Framework was used to develop the multi-item construct for the elements of work environment, as well as a single item construct for each of the identified CSFs of LSS implementation in the ED. As described previously, the constructs were developed from the results of both the Content Analysis and the Expert Study including adapting or adopting items from existing surveys when possible. The data for this phase were collected using an online survey questionnaire focused on gauging perceptions regarding the implementation of LSS in ED. The survey was been pilot tested before sent to the participants, and then conducted as a web-based survey using the UCF Qualtrics service. Experts from Round 1 of the Expert Study (Phase 3) were invited to participate in Round 2 of the Expert Study. In addition to the Experts from Round 1, the invitation was also extended to additional potential experts to expand the sample. A comparative analysis was conducted in order to identify any significant differences between the existing experts and new participants and the results showed that the two samples could be combined. The study samples of this research include industry experts who have directly participated in conducting LSS project to improve an ED. In addition to these experts, academic experts who have published journal articles on applications of LSS in an ED were also canvassed. The sample size for this study is 49 participants including 33 experts from Round 1 of the Expert Study and 16 new participants..

3.4.2 Pilot test

A pilot test is a technique used to test a questionnaire to promote efficiency and achieve success in building a survey using 10% of the planned sample size (Sincero, 2012). Because Round 1 and Round 2 of the Expert Study need at least 30 samples both to meet the requirements for

expert study best practices as well as to meet the minimum requirements for a valid EFA modeling for the WE construct, the pilot test required a minimum of five samples. Six experts, who have quality healthcare experience, participated in the pilot test and provided feedback on the survey content and design including ensuring that the questions were appropriate for the target population and to evaluate the appropriateness of their content (Sincero, 2012). In addition, the pilot test provides valuable information on whether the questionnaire is effective in fulfilling the purpose of the study. After obtaining and analyzing the results of the pilot test, various issues, including of a technical or logistical manner, were addressed and revised before the results were sent to the target participants, which include industry professionals and academic researchers through relevant professional networks and societies.

3.4.3 Data collection

A web-based survey questionnaire was developed consisting of two sections: demographic questions and five-point extent Likert Scales (i.e., 1= Not at all 2= Very little extent 3= To some extent 4= very large extent 5= To a great extent) and agreement scales (i.e., 1= Completely disagree 2= disagree 3= Neutral 4= Agree 5= Completely agree) (Bishop & Herron, 2015). Based on these scales, the participants were asked to indicate the degree to which they agreed with the provided statements or the extent to which they had observed some phenomena related to three primary concepts: factors that affect successful implementation, outcomes of implementation success, and the elements of work environment. The participants were asked to consider the most recent LSS project that they participated in or directly observed in an ED. The UCF Qualtrics service was used to build the survey and collect the data. The survey invitation was sent via email to potential participants including a link to the online questionnaire.

3.4.4 Statistical analysis

Once the data were collected from the field study survey, statistical analyses techniques for construct development were used to develop a multi-item construct for work environment. First, exploratory factor analysis (EFA) (Gunday et al., 2011) was used to identify the underlying latent constructs among the identified elements of work environment. Reliability analysis via Cronbach's alpha (Sadikoglu & Zehir, 2010) was then used to measure the internal consistency or reliability of the developed work environment construct. Reliability describes how well a test measures what it should and Cronbach's alpha is also used to investigate if multiple-question Likert-scale surveys are reliable. Cronbach's alpha identifies if the test is accurately measuring the variable of interest.

Once the WE construct had been developed, descriptive statistics were evaluated for work environment and the CSFs. Bivariate correlation analysis (Luo et al., 2015) was then used to explore the relationships between work environment and the success of LSS projects, achievement of outcomes, and sustainability of outcomes. Finally, mediation analysis was conducted to investigate the additional effects of the independent variable (LSS factors) directly on the dependent variable (LSS outcomes) in relation to the effect of the mediator variable (work environment).

The standard approach to conducting EFA is to have 5-10 observations per item in the survey. Since the work environment construct in the survey had 6 items, a minimum sample of 30-60 observations were needed to conduct the EFA. As Round 2 of the Expert Study obtained 49 observations from subject-area experts, the sample can be considered sufficient to conduct EFA to develop the multi-item construct of work environment.

3.4.5 Limitation of survey

Although surveys are a useful tool to help researchers gain the needed information, there are certain challenges that could be faced while conducting the survey. The distribution list is one of the important factors upon which the researcher should focus. Choosing the right target group and appropriate audience could avoid a low response rate. Because the response rate is the main challenge during the survey study, multiple steps have been taken into consideration to address this issue such as avoiding creating survey questions that are too long; developing an appropriate invitation plan including a series of emails and reminders; sending the invitation emails to relevant research communities and associations, such as the *American Society for Quality*, the *American Society for Engineering Management*, and the *Quality Control & Reliability Engineering of the Institute of Industrial & System Engineering*, as well as social media such as LinkedIn; and designing the survey in a clear, concise, and unbiased form to encourage completion (Abu Hassan et al., 2005).

3.5 Discussion & Methodological Justification

This proposed research has various phases, beginning with the comprehensive literature review using the systematic technique (Chapter 4). In the second phase, an Initial Conceptual Framework was then developed based on the Content Analysis that inductively synthesized the success factors of LSS implementation in ED including the most commonly achieved outcomes (Chapter 5). The third phase in this study involved conducting Round 1 of the Expert Study to develop final model of successful implementation of LSS in EDs that includes CSFs, challenges, outcomes, and work environment, which is presented in Chapter 6. Round 2 of the Expert Study

(Phase 4) was conducted to determine the latent constructs of work environment in LSS implementation as well as to investigate the relationship between work environment and the different aspects of successful LSS projects, the results of which are presented in Chapter 7. Data collected via web-based questionnaire, consisting academic experts who have publications in the same area as well as industry professionals who have participated in LSS projects in an ED. The results from the Expert Study were based on perceptions of experts because the inputs of such professionals will be grounded in their experience and knowledge of the implementation.

A two-round expert study was used to provide experts with the opportunity to reflect on the LSS implementation and how the elements of work environment affects LSS projects. First, the qualitative data from Round 1 of the Expert Study were analyzed using GT coding (open, axial, selective) to develop the Theoretical Model of the process of LSS implementation in the ED, as well as explore the factors that affect this process. The findings illustrate aspects that impact the implementation of LSS in the ED including preparation, execution, support, work environment, outcomes, barriers, and measurements. Round 2 of the Expert Study consisted of a quantitative survey developed based on the results of the Content Analysis (Phases 2) and Round 1 of the Expert Study (Phase 3). The 36 experts that participated in Round 1 of the Expert Study (Phase 3) survey were all invited to Round 2 of the Expert Study survey (Phase 4). The survey was also sent to a wider sample frame to obtain a larger sample to develop the work environment construct and investigate its effects. These sub-studies work together to develop the Final Statistical Model in the area of LSS implementation in the ED that supports practical applications. Healthcare practitioners in EDs will be able to undertake an audit of the most critical elements of work

environment to understand the extent to which any of them is lacking and develop strategies to mitigate their effects to support the implementation of LSS projects.

This study contributes to the existing knowledge of LSS implementation, industrial engineering, engineering management research areas, and the quality health care research area. The reviewed literature demonstrates the gap in implementing LSS by focusing on the elements of work environment, while most scholars have focused on the entire process from the patient perspective, not the staff perspective. Hence, this study bridges the gap and provides another perspective to the implementation of LSS. A systematic literature review and bibliometric analysis are also provided in this research to extract peer-reviewed journals that are relevant to the review questions. The SLR reveals the past and current works in the field as well as reflects trends of how LSS is being used to improve the ED processes. This also provides a conceptual framework of success factors in LSS implementation based on literature review findings.

Previous studies identified from the systematic review have entailed looking at implementation from a qualitative viewpoint, but the present research investigates the factors from both a qualitative and quantitative perspective. This will improve the information on how LSS implementation is executed, and the feedback relationships identified between the factors can be used to predict the behavior of implementation processes and their success. Furthermore, by performing this study the author aims to expand the current research on ED as well as the usage of LSS. Based on the conducted literature review, only eight studies have involved an attempt to use LSS for ED. This study is intended to add to the existing body of research by attempting to establish new organizational procedures through LSS. This work also includes an expert study for

the conceptual framework, which can be used to inform future research and extended to encompass quality health care research approaches.

3.6 References

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CHAPTER 4: SYSTEMATIC LITERATURE REVIEW

Systematic Review of Continuous Improvement Implementations in Emergency

Departments

Note: This chapter is the first manuscript of this dissertation and an appropriately formatted version is planned to be submitted to the *International Journal of Lean Six Sigma* (IF=4.55) on July 31, 2020.

4.1 Abstract

Purpose: The purpose of this research is to systematically review the literature regarding the use of quality process improvement tools in emergency departments (ED).

Design/methodology/approach: A systematic literature review and bibliometric analysis were conducted to extract and analyze peer-reviewed journal articles that focus on using Lean Six Sigma (LSS) in EDs. Forty relevant articles were identified using the three different databases (ProQuest, EBSCOhost, and Engineering Village) search tools covering the period 2000 to 2019, as the patient volume in EDs has increased during these periods. In addition, the data are analyzed thematically to assess the current state of this area.

Findings: Continuous Improvement tools play an important role in healthcare and are used to define and assess problems helping to improve emergency care by addressing errors, prioritizing quality problems, and improve processes. Most of the work on improving the ED applied a Lean approach (23 publications), while there was regular use of applying Lean Six Sigma (13 publications). Only four publications applied Six Sigma to address different issues in ED, such as

patient length of stay, by concentrating on the whole process of the ED as well as the process flow of patients.

Originality/value: This review provides a review of pertinent papers on applying continuous improvements tools to improve the performance of ED to deliver high-quality emergency care services. The results show that there is a gap in the literature concerning the effect of the elements of work environment on successfully implementing LSS. The LSS methodology is not just for those in manufacturing and it has the potential provide great outcomes in the healthcare industry. The drive in all areas is to meet the desired customer satisfaction level while providing the best possible services by implementing the LSS approach.

Keywords: Systematic literature review, Continuous Improvement, Lean Six Sigma, Emergency Care, Work Environment.

4.2 Introduction

Healthcare is a complicated industry that faces many challenges including increased expenditures and difficulties related to individual or community access to appropriate care (Allaudeen, 2017). Such problems impact the healthcare systems in numerous countries worldwide (Albar, 2016; Hussein, 2017; Laureani 2013). In 2014, the American College of Emergency Physicians' (ACEP) published a report that indicated the environment of emergency care in the U.S. is declining in quality patient care and barely passed ACEP's assessment with a D-Plus grade, which indicates that the hospital did not do well in patient safety (Albar, 2016). The report also declared that the problems regarding access to emergency departments (ED) play an essential role in improving services (Albar, 2016). Due to growing demands and limited resources, all EDs

around the world are facing serious concerns related to the ability to deliver needed services in providing quality and efficient emergency care to patients (Albar, 2016; Laureani, 2013; Loubnan, 2018).

As the demand for ED services increases, the patient LOS will strongly increase and result in unsatisfied patients and lower quality of care (Albar, 2016; Hussein, 2017). Implementing quality improvement (QI) tools provides practical strategies to improve these processes, achieve sustained improvement, increase patient satisfaction, provide a high quality of care, and establish competitive advantages (Deniz, 2017; Hussein, 2017; Liberator, 2012). Many process improvement approaches, such as Total Quality Management (TQM), Critical to Quality (CTQ), Six Sigma, and Lean Six Sigma, have been adopted in service and manufacturing industries such as the Lean in General Electronics and Motorola (Padhy, 2017; Wang et al., 2012;). Lean Six Sigma is a continuous improvement tool that includes the integration of principles and tools from both Six Sigma and Lean. Such a tool helps to improve customer satisfaction, cost, quality, and speed (Laureany et al., 2013; Yadav & Desai, 2016).

The Institute of Medicine (IOM) also reports on emergency care in the United States by emphasizing the looming crisis in emergency care and highlighting that overcrowding is the major contributing issue (IOM, 2006). Another report published by The United States Government Accountability Office stated that "emergency departments crowding continues to occur, and some patients wait longer than recommended time frames" (GAO, 2009). Such problems impact the emergency care of numerous countries such as the United States, the United Kingdom, Ireland, Egypt, and Saudi Arabia, where their governments had to take academic and political action to classify and assess these issues (Al bar 2017; Allaudeen 2017; Hussein 2017; Laureani 2013;

McAlister 2014). To cope with this issue, multiple efforts have concentrated on the problem and developing measures of ED crowding and studying its impact on ED clinical and operational outcomes (Albar, 2016; Mandahawi et al., 2017).

Hussein et al. (2017) defined ED overcrowding as, "an extreme excess of patients in the treatment areas, exceeding ED capacity and frequently necessitating medical care to be provided in ED hallways and other makeshift examination areas". EDs are commonly known as a stressful environment, which is complicated by the increasing number of demands resulting in high volume workload and high pressure (Flowerdew et al., 2012; Johnston, 2016; Raziq et al., 2015). ED working environments are affected by many factors such as staff burnout, interpersonal conflicts, lower spirits, job satisfaction, disempowerment, limited recognition of quality work, lack of staff training, motivation issues, and difficulties with retention and recruitment (Flowerdew et al., 2012; Johnston, 2016; Lambrou et al., 2015). Working in high-pressure environments with high demand for clinical skills can negatively affect staff morale (Escribà-Agüir et al., 2006; Johnston, 2016; Ross-Adjie et al., 2007). Therefore, the outcomes of staff stress include resignation, sick leave, and turnover (Escribà-Agüir et al., 2006; Johnston, 2016). In a poor work environment, the probability of medical errors and long patient waiting time is high (Johnston, 2016; Laureani, 2013).

In the Emergency Department, the working environment has been defined by several studies. Johnston et al. (2016) indicated that the working environment includes factors affecting the professional context in which the ED staff work. Motivation is an essential factor that affects the ED staff. Staff motivation is a necessary element in a healthcare system and plays a significant role in an organization's ability to face many challenges in healthcare (Lambrou et al., 2010).

Multiple factors affect staff job satisfaction; for instance, studies of ED staff perceptions indicate overload due to the increase in the number of patients, staff shortage, and budgetary cuts (Ajeigbe et al., 2013; Johnston et al., 2016).

The objective of this study is to identify and thoroughly review existing knowledge and literature patterns as well as inductively synthesize variables (i.e., success factors) in this research area. Future research could utilize this knowledge to develop a conceptual model from factors synthesized from the literature as well as allows scientists and researchers to view the current evidence in this research area contributing to evidence-based practice. The systematic literature review technique aims to conduct a methodical and comprehensive review, targeting the most relevant studies that address continuous improvement tools in emergency department (Mulrow, 1997; Tranfield, 2003). Bibliometrics analysis is the application of quantitative analysis and statistics to analyze the captured publications, which provide a means for evaluating the development of the research area (De Bellis, 2009).

4.2.1 Process and quality improvement in emergency care

Decades ago, healthcare organizations began using process improvements to survive. Quality improvement (QI), process improvement, Six Sigma, and Lean management have been applied to improve value for money, change systems, address the cause of defect's, reduce variability, and reduce cost (Boak et al., 2017; Hwang et al., 2014). Although there are many claims of the effectiveness of these tools (Mazzocato et al., 2010; Hwang et al., 2014), some analysts have doubts about how easily these tools can be applied to healthcare organizations in practice

(McIntosh et al., 2014). These methods have been used successfully in manufacturing organizations and now are increasingly being used in healthcare (Boak et al., 2017; Deniz, 2017; Loubnan, 2018). Although there are many tools and approaches used for QI, there are broad similarities between these methods (Loubnan, 2018). QI focuses on waste reduction as well as customers' value, which is an essential concept in healthcare, leading to better outcomes for patients. Process improvement focuses on redesigning and analyzing processes and systems to make them more efficient and effective. For example, Six Sigma and Lean are approaches that focus on eliminating waste while continuing to satisfy customers (Loubnan, 2018; Furterer, 2018; Hussein, 2017; Deniz, 2017).

Lean Six Sigma is a continuous improvement approach that focuses on improving customer satisfaction, speed, quality, and reducing process variation and defects. Sreedharan and Raju (2016) listed a compilation of LSS definitions from various research and categorized by different authors in different themes such as methodology, system, model, and approach. This approach has been used successfully in both manufacturing organizations and healthcare organizations to improve their competitiveness, effectiveness, and efficiency (Prashant and Sandeep, 2017). The Lean Six Sigma methodology has well-studied principles in healthcare due to its efficacy for reducing medical errors and its zero-tolerance for mistakes (Laureani et al., 2013; Alcaide-muñoz & Gutierrez-Gutierrez, 2017). Numerous healthcare organizations have implemented Lean Six Sigma projects (Antony et al., 2006). Generally, the objective was to improve measures such as safety, efficiency, quality and customer satisfaction, to identify and eliminate waste, to improve clinical processes, and to support staff to examine their workplace (Antony et al., 2006). DMAIC is the problem-solving approach behind Lean Six Sigma and it consists of five process

improvement phases: design, measure, analyze, improve, and control (Freitas and Costa, 2016; Loubnan, 2018). Many organizations applied and distinguished the DMAIC process from other QI tools due to the robust framework that leads teams to analyze root causes to long-term, stable standard work (Jansson, 2017). The observed advantages indicated an increase in cost savings, a decrease in defects (errors), and an improvement in customer satisfaction (Chugani et al., 2017; Garza-reyes, 2015; Kahl, 2005;). The DMAIC achievement now extends beyond the cost-saving objective, to improve the quality in the healthcare industry with a concentration on patient safety (Kahl, 2005).

Process improvement approaches such as Six Sigma and Lean are being applied to make necessary changes in healthcare. Additionally, both methodologies are now commonly employed in manufacturing and service (Prashant and Sandeep, 2017; Laureani et al., 2013). Case studies in the service industry include health care delivery services (Cimen, 2017; Leone and Rahn, 2010) and HR administration (Syahputri, 2018). Welding wires (Hassan, 2013) and Litchi Juice Production Plant of foods and beverage industries in Bangladesh (Hossain, 2015) are examples of studies that implemented Lean Six Sigma in the manufacturing industry successfully. All these studies used both Six Sigma and Lean successfully and achieved excellent outcomes and benefits, including reducing waste, improve quality, regulate cost, and increase customer satisfaction customers (Deniz, 2017; Furterer, 2018; Hussein, 2017; Loubnan, 2018). Hence, there should be an attempt to adopt such a tool successfully to improve the emergency department to capture the same benefits (Leggat et al., 2016; Wang et al., 2015; Furterer, 2018; Uppal et al., 2012; Shakoor et al., 2017; Allaudeen et al., 2017).

In this paper, a systematic literature review (Moher, 2009) is conducted on continuous improvement tools and emergency department research. The various studies show implementations of different quality improvement tools in various emergency departments. The statistical analysis shows the frequency of these studies. The systematic review supports the analysis of evidence, using transparent and rigid approaches to generate empirically accomplished answers to focused research questions (Boren, 2015; Cronin & Ryan, 2008; Mandrekar & Mandrekar, 2011). Such a literature review will also support the interest for the particular research area and helps to identify the gap and define the scope (Bryan & Boren, 2008; Boren, 2015). The SLR approach used in this research was designed to be relatively precise in order to capture relevant publications that adequately represent recent work in this area from 2004 to 2018, which contains the period of time when there has been a significant increase in the patient volume in EDs.

4.3 Research Methodology

This systematic literature review was conducted following the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher, 2009). The systematic literature review is a protocol in which a body of literature is collected, reviewed and evaluated while using pre-determined and standardized strategies (Štrukelj, 2018). In an SLR, the aim is to distinguish, fundamentally assess, and summarize the current evidence concerning a clearly defined issue. The technique of data collection, the rationale, and the hypothesis are prepared prior the review to reduce the bias (Štrukelj, 2018; Moher, 2009). The review procedure for this systematic review was developed to reduce the probability that the review would influence by

researcher expectations. The process of executing a systematic review consists of six phases (Štrukelj, 2018):

- 1- Define the objectives of the review clearly.
- 2- Define the methodology of the review and identify eligibility criteria.
- 3- Recover qualified literature and completely document the research strategy throughout the process.
- 4- Evaluate the methodological quality of the selected literature and exclude the papers with low methodological quality.
- 5- Identifying the needed papers from all the selected studies and summarize the findings.
- 6- Collect the results of different studies and write them in a narrative form.

The SLR technique help the research to be a precise search that identifies as many of the existing publications as possible while remaining feasible in terms of number of search results.

The review focuses on answering the following research questions:

- What type of continuous improvement tools are being used to improve the emergency care in recent years?
- What measures were targeted or improved during the CI implementation?
- What are the factors that affect the successful implementation of LSS in emergency care?
- How has the research of continuous improvement in emergency care evolved in recent years?

The systematic review (Boren, 2015; Bryan & Boren, 2008; Moher, 2009) and bibliometric analysis (Garfield 2009; Hood and Wilson 2001; Keathley-Herring et al., 2016; Patra et al. 2006; Schoepflin and Glanzel 2001; Smith 2012), which uses quantitative or statistical assessments to describe the publications. As the process for this review involves defining the research question and research strategy, the following sub-section discuss the strategy of this research.

4.3.1 Research Strategy

A search strategy for the review was used to find a comprehensive group of papers relevant to answer the identified research questions. The search strategy included defining the search scope and vetting process to be used in identifying relevant studies (Kevin et al., 2018). The search strategy permitted the development of a replicable and open review of external literature (Kevin et al., 2018). Current academic literature in the field of continuous improvement tools in emergency department including journal articles, conference presentations, proceedings, textbooks, and dissertation/thesis were considered as key sources for this review due to the nature of the concept of research area maturity, which is mainly relevant to the academic community.

The research began with a scoping study of seven papers related to this research area (Allaudeen, 2017; Furterer, 2018; Hossam, 2018; Hussein et al., 2017; Leggat et al., 2016; Majid et al., 2013; Taner et al., 2009; Uppal et al., 2012), which primarily consisted of case studies in ED. The relevant papers were identified across multiple platforms, such as ProQuest, Google Scholar, and Research Gate. These seven publications illustrated the scoping set of papers and were used to create the search strategy.

According to Boren (2015), a SLR considered an extensive search to capture and summarize the available information related to the research area. Following a flexible and customizable approach help to achieve a balance between sensitive and accurate search (Gonzalez-Aleu & Van Aken, 2016). Sensitivity of the search is a measure of the ability of a search strategy to identify all relevant publications, which can be controlled through aspects of the search strategy

such as search terms, limiters used, structure of the Boolean phrase, and exclusion criteria (Gonzalez-Aleu & Van Aken, 2016; Boren, 2015).

The initial search strategy technique started with identifying three essential concepts of this research area based on the papers in the scoping set, which used as search terms (shown in Table 4.1): Emergency Department, Continuous Improvement, and Implementation. Under each concept, many possible alternative phrases or terms were explored, which included iterative testing of each term to identify a final set of relevant papers for this research area. First, in addition to Emergency Department, Continuous Improvement, and Implementation, related search terms, such as emergency room, emergency room, quality improvement, process improvement, six sigma, lean, and Lean Six Sigma, were included to increase the sensitivity of the search. These additions helped to obtain additional papers related to continuous improvement in the ED. Second, the initial search strategy technique was revised to increase the research sensitivity. Additional search terms related to "implementation" such as, deploying, using, applying, and executing were included, which describe CI projects that applied in the ED. All potential search terms were tested to determine whether they should be retained by evaluating the capture rate (i.e., the number of scoping study papers captured by the search containing those search terms). An iterative process was used to test the search terms and the literature search was conducted using the final list of keywords shown in Table 4.1.

Table 4.1 Key Concepts & Search Terms

Emergency Department	Continuous Improvement	Implementation
Emergency Department	Continuous Improvement	Implement
Emergency Room	Process Improvement	Implementing
Emergency Care	Quality Improvement	Implementation

Emergency Services	Lean	Execute
Emergency Healthcare	Six Sigma	Executing
Emergency Health care	Lean Six Sigma	Deploy
		Deploying
		Use
		Using
		Apply
		Applying
		Application

Next, the final Boolean phrase was developed and tested on three different platforms including ProQuest, EBSCOhost, and Engineering Village to ensure that it could be constantly applied on all platforms. The three platforms are chosen to maximize the coverage of literature through different databases. In addition, the three platforms were selected for their specialty in industry and practitioner-focused work as well as in business, psychology, sociology, science, and engineering disciplines. All the available databases of the three platforms were included in the search to allow for publications from all research areas to be included in the results. The results from the final search are summarized in table 4.2.

Table 4.2 Final results per platform/database

Platform/Database	Raw result	Limited result	After duplicated removed	Related articles
ProQuest	2,843	2,276	1,743	29
EBSCOhost	83	82	60	2
Engineering Village	143	131	141	9
Total	3,069	2,489	1,944	40

As this study is focused on emergency care particularly, implementation of CI tools in other department of the healthcare organization were excluded. Strictly related concepts like total quality

management projects for specific clinical processes and parameters were also excluded. In addition, the review excluded studies that present the concepts and principles of CI tools in general other than the implementation processes. Studies that focusing on other fields rather than healthcare were also excluded. Figure 4.1 summarized the exclusion criteria of studies.

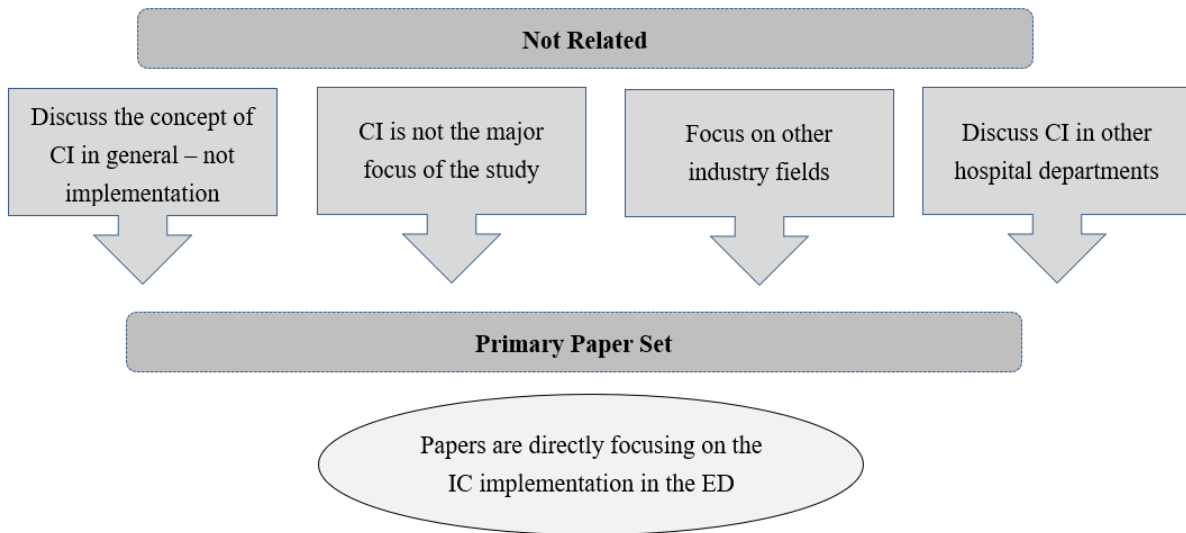


Figure 4.1 Exclusion Criteria

The exclusion criteria were applied in the three phases of reviewing the raw results. The first phase consisted of reviewing the titles and abstracts of all the results. Search terms should be included in these sections so that the related studies could be identified. Abstracts consist of key terms, objective, methodology, and results of the study. In addition, reviewing the titles and abstract enables the researchers to judge the relevance of the work for their study and decide

whether to include or exclude the paper. In this phase, the researcher can follow the scanning-read strategy, which aids to regulate the amount of time the researcher spent on each title and abstract.

The second phase is focused on reading and critically analyzing the full text of each study the researcher selected in the first phase and determining whether the paper will be included in the analysis and discussion. In this phase, each study is evaluated based on multiple criteria, such as the clarity of the research questions, the validity of methods to address the questions, and the importance of the valid results. Failure to meet one of these requirements is evidence that the paper should not be included in the final set of papers. Once the final paper set has been identified, the collection of papers is studied carefully using bibliometric analysis. In future work, the selected related papers will be synthesized to develop an Initial Conceptual Framework of factors that affect LSS implementation success in EDs. A grounded theory approach will then be used to investigate expert experiences and further refine this model for empirical testing.

The initial results identified through database searching was 2,489 publications, covering the period 2000 to 2019, as the patient volume in EDs has increased during these periods (AHA, 2016). The other limiter applied was that the publications must be in English language, which taken into consideration that results in different language was less 3%. After duplicates were removed, the results were reduced to 1,944 publications. Of these journal articles, 40 articles were selected for the literature review. Figure 4.2. summarized the study selection process and number of studies selected at different stages.

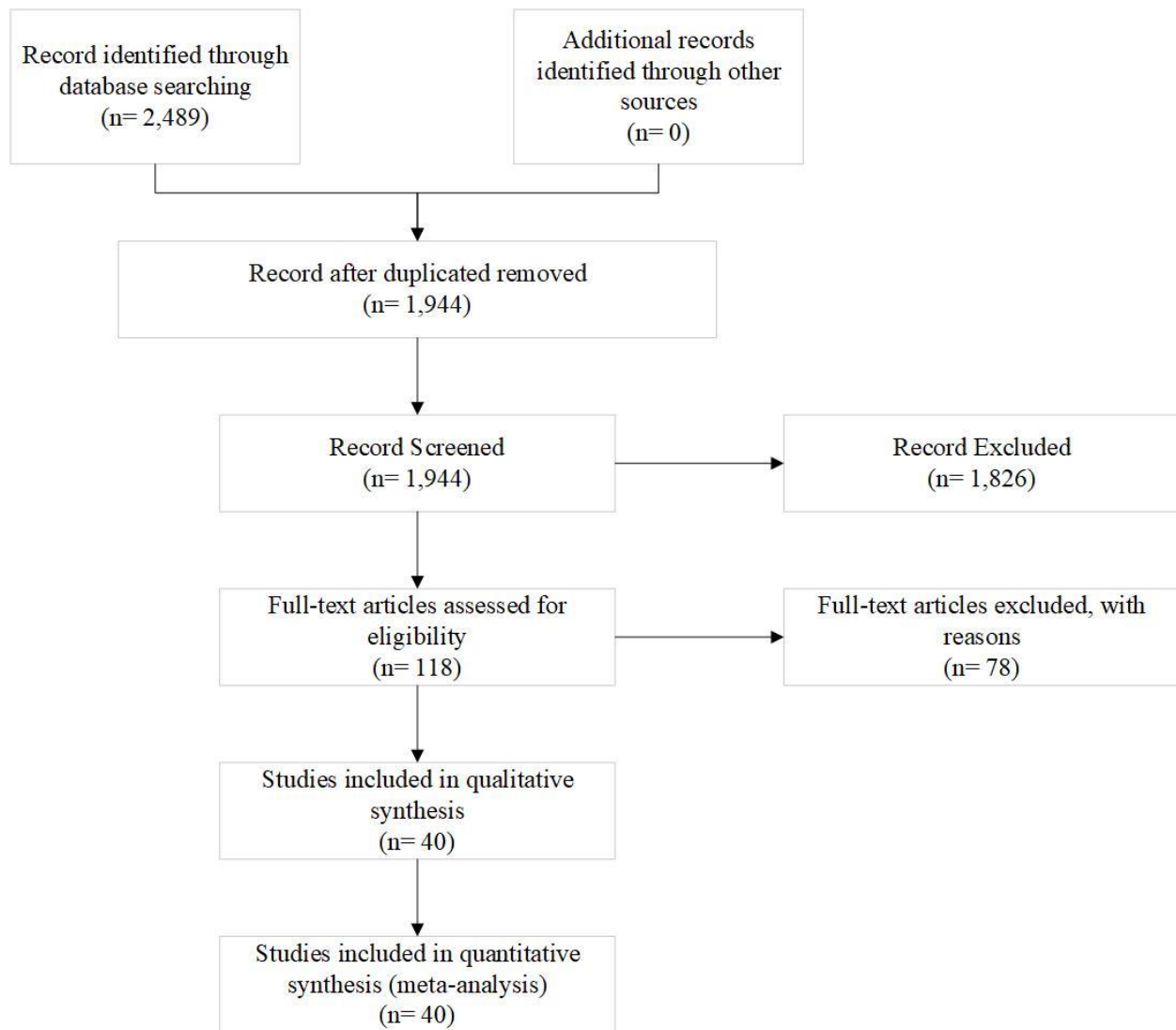


Figure 4.2 Study selection process for the literature review

The 40 documents identified with this process were then used for the bibliometric analysis, which uses quantitative assessments to describe the related publications (Keathley-Herring et al., 2016).

4.4 Bibliometric Analysis

As mentioned previously, 40 unique and relevant papers were selected for this study and this section summarizes the results of a bibliometric analysis of the selected studies as well as a general exploration of evidence available in the literature to investigate relationships and trends. The 40 papers in the final paper set were evaluated based on publication trends, research methodologies, and continues improvement tools. Further, the purpose and outcomes studied were investigated. The following sub-sections provide a detailed analysis of the studies.

Publication Trends

The analysis of publication trends consisted of a visualization of frequency of publications to determine the extent to which this frequency is changing. Figure 4.3 summarizes the publication trends for this research area. In regard to determining the causes of variation in publication frequency, there are several factors to consider. For instance, the rigor or scope of these publications can be a factor as to rising or decreasing frequencies considering that quality of the research is essential for credibility in an emerging area of study (Sandstrom & Besselaar, 2016; Chen, 2019). As progress is made, it becomes more difficult to contribute to the research area and we may see bursts of activity around sub-areas of the research. Another possible factor that may affect the prevalence of publication is the number of researchers and industry professionals who participate in the research community (Saha et al., 2003). In other cases, the magnitude of a certain social occurrence may also trigger the increasing frequency of publication, particularly when it is

to be considered to play a significant role in improving a society's holistic approach to life. This can be easily recognized particularly when life and death is involved (Filion & Pless, 2008).

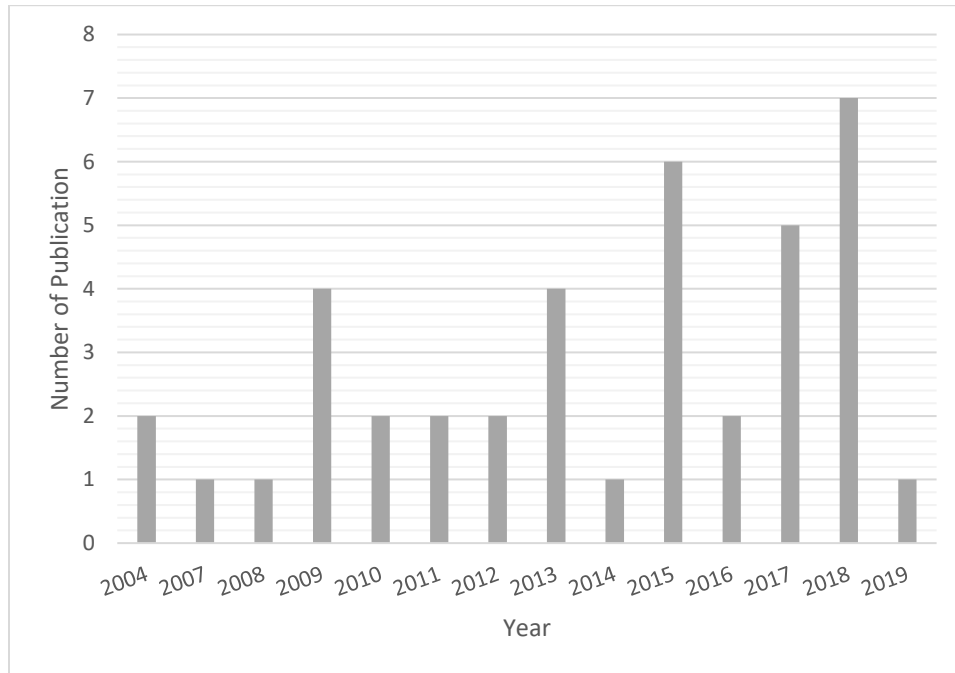


Figure 4.3 Publication per year

Figure 4.3 summarizes the frequency of publications per year, which shows a general increasing trend. This is expected considering the growing recognition of the potential for CI tools to improve the ED, which is a critical area of health care. The analysis showed that most of the studies were published in the years of 2015, 2017 and 2018; however, the initial burst in activity in this area was in 2009, demonstrating that the research area was active between 2004 and 2012, but with a highly fluctuating publication frequency. This may be due to challenges of studying ED, which are mission-focused environments where operational disruptions are often unacceptable.

However, there is an evident increase of publications in recent years, demonstrating that this area has become an active area of research viewed as important across many disciplines.

The result shows that, although there is a general increasing trend, the overall number of publications is still relatively low and the frequency is inconsistent demonstrating the need of more studies to be conducted as many healthcare professionals are calling for improvement in emergency departments to enhance processes, optimize the quality of provided care services, and improve patient satisfaction. According, in this particular study, the observed recent increase in publication frequency may be due to the increased need for emergency departments to improve its capacity to provide higher quality of their services and therefore increase the level of patient satisfaction and improve overall health outcomes. Moreover, recent publications have provided additional evidence of the potential capacity these CI tools to improve operational (i.e., nonclinical) performance, which has led to higher numbers of studies being approved, published and applied either in future research or in practice (Yeh et al., 2012; Improta et al., 2018).

Research methodology

It is crucial for a research study to utilize research methodologies that allow them to contribute to advancing knowledge in a research area. Without an effective and appropriate research methodology, a study's results may not be effective and/or useful (Rajasekar et al., 2013).

The results of this study, summarized in Figure 4.4, show that qualitative methods were most commonly used in this research area. It is clear from the identified studies that most of the research concerning the implementation process for continuous improvement tools are case studies

emphasizing the exploratory nature of this research (Awaad, 2018; Dickson et al., 2009; Mandahawi et al., 2017; Zanin et al., 2011). In some cases, quantitative methods were also used including survey studies (Poole & Mazur, 2010) and there was fairly regular use of the mixed-methods in the studies, which consists of both qualitative and quantitative techniques (Mari et al., 2008; Allaudeen, 2017; Al Owad et al., 2018; Holden et al., 2012).

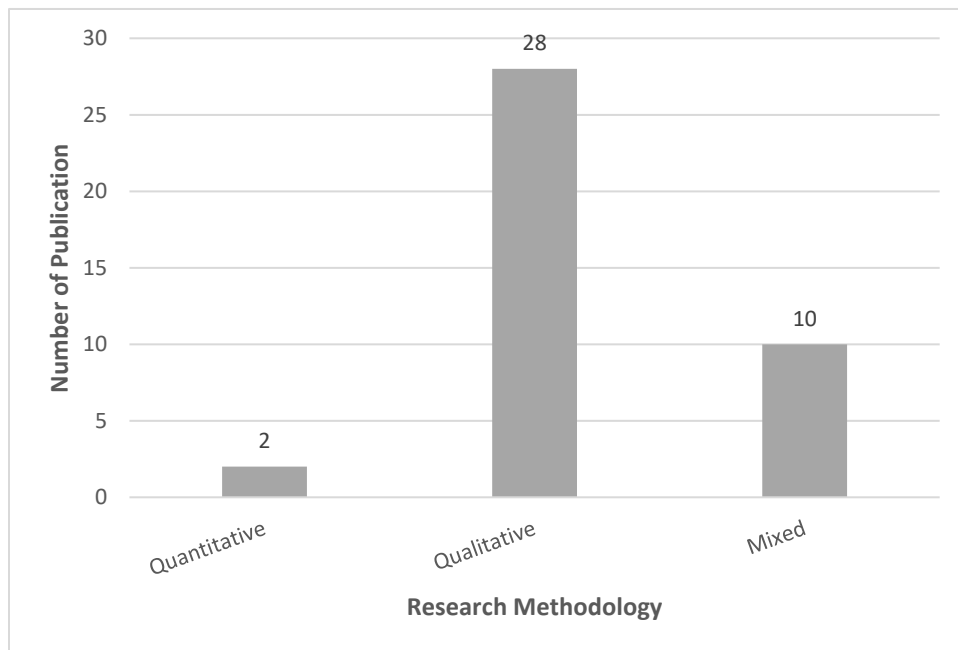


Figure 4.4 Research Methodologies Used in the Final Paper Set

Over the years, qualitative methods have been used extensively in healthcare studies demonstrating several significant contributions to both health services and policy research. In particular, qualitative research is designed to obtain a more profound understanding of a particular phenomenon. It aims to capture more subjective and less quantifiable empirical evidence, and has been used in many areas to develop theoretical understandings of phenomena. For example,

researchers used a qualitative approach to investigate how manufacturing tools have been implemented in ED. This research argued the need to determine the behavior of the people involved thus requiring a more subjective process of the research (Hammarbeg et al., 2016).

The prevalence of qualitative methods used in research methodologies can also be associated with the prevalence of the lean approach in the different research papers reviewed, which is generally a qualitative approach (Al-Busaidi, 2008). There were 23 studies that applied the lean approach, aiming to improve various aspects of the emergency department leveraging qualitative methodologies. The goal of the lean approach is to support continuous improvement, which addresses three objectives. These objectives involve eliminating inconsistency, overburden, and waste with the help its two pillars: “respect for people and continuous improvement” (Holden, 2011; Naya, 2009). Similar to other industries, healthcare organizations can also be recognized as a multifaceted business system, which requires the need to balance the amount compensated for the medical care services as well as for the overall outcome produced from them seeing the needs of significant expectation groups involved such as the employees, patients, and hospital leaders (Abeidi et al., 2018; Chafe, 2017).

Continues improvement tools

According to Lande & Shrivastava (2016), Lean Six Sigma has been demonstrated to be effective in enhancing the healthcare sector. Lean consists a set of philosophies that supports the creation of maximum value for the patients by reducing wastes. Six Sigma, on the other hand, is a management tool that is used explicitly in organizations that need to improve business processes of by reducing any likelihood of error occurrences (Deniz, 2017). When the Six Sigma is employed

in healthcare, it supports in the improvement of quality patient care, reduction of many forms of wastes, and eliminating defects (Antony et al., 2012).

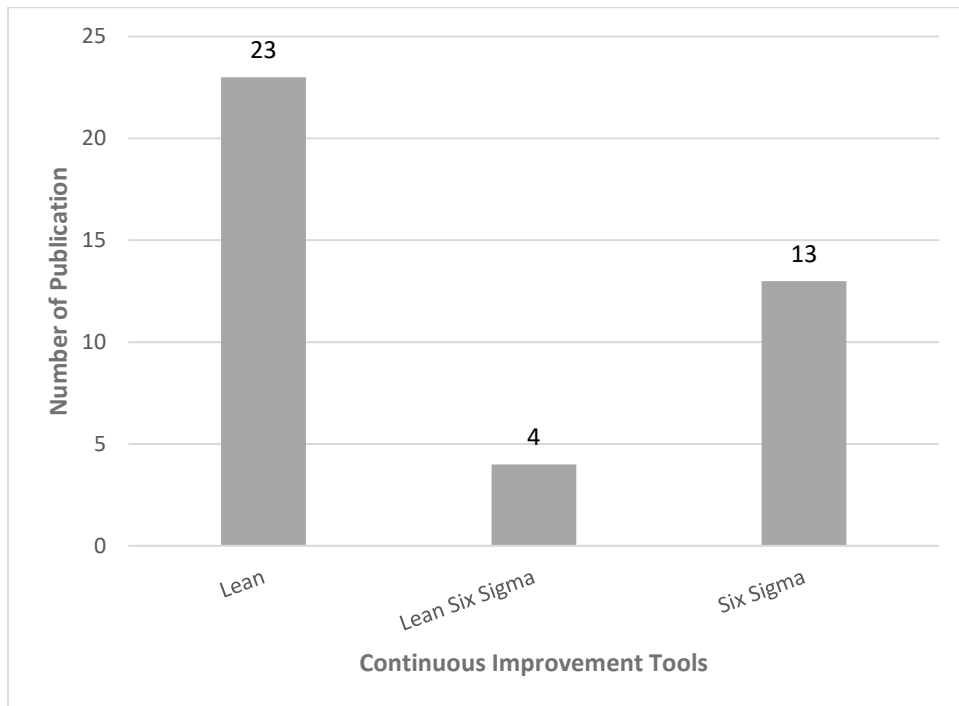


Figure 4.5 Continues Improvement Tools

Figure 4.5 demonstrates that there were three different continuous improvement (CI) tools used to determine the findings of this research, and out of three, it was the Lean approach that ranked the highest with 23 studies that used it followed by 13 papers that used Six Sigma, while only 4 studies have been found to have used Lean Six Sigma. In order to successfully obtain the required changes or improvements in healthcare organizations, both the top management and employees must participate in the implementation. The analysis shows that there were only four studies that used the Lean Six Sigma approach and a deeper review revealed that some healthcare organizations have shown concern regarding the execution process and on the required change in

organizational culture. Moreover, considering that the application of this tool aims to focus on those that are based on needs, structure and goals of the organization, the healthcare organizations have only dared to apply it if it totally necessary in an attempt to avoid possible waste for the whole organization (Hitti et al., 2017). As for the Lean approach, it seems to carry a lesser possibility of waste, followed by how the Six Sigma has also been used. The latter has been used because of how it provides a general focus on cost reduction, efficiency, increasing of profitability and improved quality of performance (Leggat et al., 2016; Wang et al., 2015; Uppal et al., 2012; Shakoor et al., 2017; Allaudeen et al., 2017). It is able to address a high variety of issues that healthcare organization may encounter. As for the Lean approach, it addresses those issues that were critical for emergency departments and the long-term functionality of the healthcare industry.

4.4.1 Matrix plot

Matrix plots were used as an additional type of statistical analysis of the studies. It uses commonly utilized data to find relationships between two variables, which can help the analyzer to assess the possible causal relationship between the plotted variables (Meloun & Militky, 2011). In Figure 4.6. the first dimension indicates the number of selected studies using different research methodologies, while the second dimension indicates the year of publishing studies. Figure 4.6 also shows that there is a regular interval use of qualitative methods in CI tools studies, while there is a low interval use of quantitative and mixed methodologies.

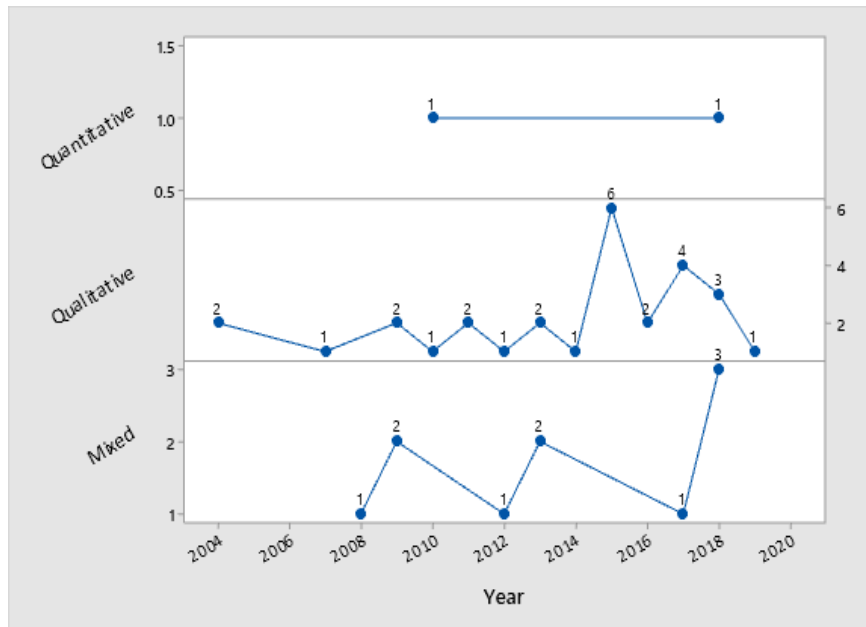


Figure 4.6 Matrix Plot for the number of studies in different research methodology vs. year

Figure 4.7 presents the distribution of the number of studies implementing different CI tools in the ED. It is clear from this chart that there is regular interval use of Lean approaches with 23 studies between 2004 and 2019 and there is a significant increase of the implementation of Lean from 2011 to 2018. On the other hand, there is a better interval use of Lean Six Sigma with thirteen studies and low interval use of Six Sigma with only four studies.

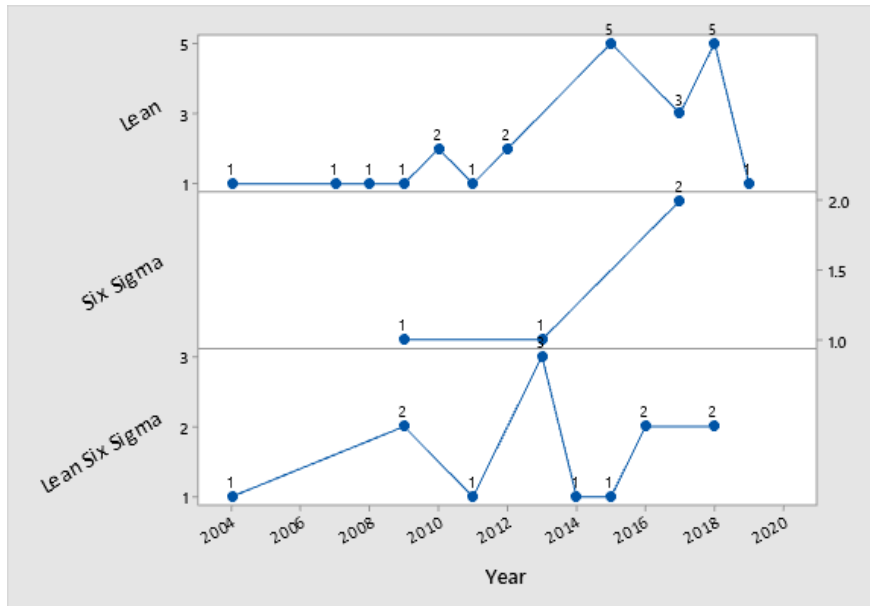


Figure 4.7 Matrix Plot for number of studies using different CI tools vs. year

Lean Six Sigma has been utilized in big healthcare organizations managing with complicated processes rather than smaller organizations confronting with simpler processes that can't bolster the expense of executing Lean Six Sigma (Papic, Mladjenovic, Garcia, & Aggrawal, 2019). Implementation success will depend on the selection and the development of the Lean Six Sigma approach and its implementation effectiveness. There are multiple factors that could affect the implementation model such as culture, current organization's strategic goals, current organization continuous improvement maturity, and resource capability (Papic et al., 2019). Therefore, the results showed that studies that have been conducted using Lean Six Sigma in the ED are rare in recent years, which emphasizes the need for mixed methods research with a holistic understanding of Lean Six Sigma as well as more robust empirical analyses. This work intends to help both researchers and practitioners to be able to develop better understanding of success Lean Six Sigma implementation principles, hence determining the missing links. The results of the

bibliometric analysis aid the status of the literature and help identify essential aspects about the problem. The results of the analysis aid the status of the literature and help identify essential aspects about the problem. The following section presents the data synthesis and analysis, which provide a detailed summary of the selected relevant papers.

4.5 Data Synthesis and Analysis

This systematic review strategy identified 40 unique and relevant peer-reviewed papers. The selected papers are categorized according to the continuous improvement tools, including Lean, Six Sigma, and Lean Six Sigma. A detailed summary of the articles identifying the improvement tool, such as Lean (Table 4.3), Six Sigma (Table 4.4), and Lean Six Sigma (Table 4.5), as well as the measure which includes the authors and year, details of work done, and the improved measures. The last column of the table provides the research methodology for each paper.

4.5.1 Lean Studies

The Lean approach has been applied to improve different aspects of ED such as value for money, change systems, reduce variability, eliminate defect error, and improve patient satisfaction. Table 4.3 shows numerous studies that used Lean thinking approaches to improve the emergency departments. Twenty-three studies included in the literature applied this approach.

Table 4.3 Summary of Studies using Lean

Author/Year	Summary	Improved Measures/Objectives	Research Methodology
Holden et al. (2012)	Utilized Lean thinking to improve emergency department in Sweden. Qualitative data collected using semi-structured interviews. Analyzed data using statistical process control techniques and ANOVA. Efforts in the right direction. Helpful achieving and sustaining improvement in patient waiting time by 19-24% in the two following years.	Job satisfaction Process Flow	Mixed methods (quantitative, qualitative)
Hitti et al. (2017)	Aimed to investigate the effectiveness of applying Lean approach for improving the ED transportation time for plain radiography. Mean transportation TAT used to analyze the data. Significant improvement in patient LOS and intervention time	ED Boarding ED overcrowding	Qualitative (case study)
Pondhe et al. (2004)	Implemented Lean manufacturing technique in ED to improve performance included different factors (patient-centered, efficient, safe, cost-effective). Data collected from the ED database. Data analyzed using statistical techniques.	Process Flow	Qualitative (case study)
Wang et al. (2015)	Utilized value stream map based on Lean principles and simulation to design and analyze ED. Goal to reduce waiting time and increase the service level. Result showed reduction in patient wait time (78 to 38 min). Service level increased (54% to 88%).	ED layout Waiting time Staff assignment	Qualitative (case study)
Kelly et al. (2007)	Implemented Lean thinking to redesign the process and improve ED efficiency. Non-parametric method conducted to analyze data. Results indicated reduction in patient waiting time and increase in total hrs. of care delivery by 8.4%.	Process Flow	Qualitative (case study)

Author/Year	Summary	Improved Measures/ Objectives	Research Methodology
Uppal et al. (2012)	Used a Kaizen Event to improve processes, reduce the discharge process time, eliminate waste, and enhance the workplace in ED. Different tools (value stream mapping, process mapping, and statistical process analysis) used to analyze the data. Average 50% reduction in patient discharged time.	Patient LOS Process Flow Process Time	Qualitative (case study)
Meyer (2010)	Adopted a Lean performance improvement technique to provide better care services at Denver Health Hospital. ED adopted the system of patient fast-tracking, which reflected reduction of patient LOS.	Medical errors	Qualitative (case study)
Abdelhadi (2015)	Investigated Takt time based on Lean manufacturing technique. Aimed to measure the patient treatment (Male and female) lead time within two EDs. Concluded that Takt time be used to measure different services efficiency in various departments.	Patient Service	Qualitative (case study)
Poole and Mazur (2010)	Investigate how the workforce in ED affects the implementation of the Lean approach. Five projects undertaken during implementation: small scope 5S, Moderate scope 5S, Lean experiments, Kaizen, large scope 5S. Survey conducted to run statistical analysis.	ED staff	Quantitative (survey)
Improta, et al. (2018)	Implemented Lean Thinking strategy to improve ED process. Data collected in two different periods (beginning and after the improvements) for comparison. Results indicated increase in ED performance and patient waiting time.	Patient LOS Patient Flow	Qualitative (case study)
Jacko and Kumr (2015)	Presented Lean principles to improve the process flow and enhance patient satisfaction. Focused on various factors:	Patient LOS	Qualitative (case study)

Author/Year	Summary	Improved Measures/ Objectives	Research Methodology
	communication and stakeholders. Conducted some statistical analysis and Lean tools (fishbone tree of process flow).		
Shakoor, et al. (2017)	Employed Lean-thinking approach in cutting down the patient waiting time in ED's. Studied four sections: bed occupancy, Female Treatment Room (FTR), Male Treatment Room (MTR), Female Observation Room (FOR), Male Observation Room (MOR). Calculated Takt time to find the waiting time for use of emergency services. Used extra beds in four rooms in ED allocated to the other crowded rooms in the same department.	Patient LOS	Qualitative (case study)
Dickson, et al. (2009)	Described the results of implementing Lean on quality of provided care services in four ED's. Measured some metrics: patient flow, patient satisfaction, and patient LOS. Results showed the reduction of patient length of stay in 3 of the EDs with increase in patient volume in all 4.	Patient LOS Patient Satisfaction Patient Flow	Qualitative (case study)
Allaudeen (2017)	Evaluated Lean approach to reduce patient LOS in ED for medical admissions. Performed process improvement workshop to determine the root causes of problem, assess current process, develop countermeasures. Results indicated improvements and reduction of patient LOS by 26.4%.	Patient LOS Patient Flow	Mixed methods (quantitative, qualitative)
Martínez, et al. (2015)	Used Lean approach to improve patient care time. Identified significant factors causing delays and long wait time for treatment. Used simulation to show significant improvement in consultation time and patient waiting time.	Patient LOS	Qualitative (case study)
Teng-Kuan, et al. (2015)	Used Lean principle and simulation optimization to improve the ED layout design and staff assignment issues. Used	Patient LOS ED layout Staff assignment	Qualitative (case study)

Author/Year	Summary	Improved Measures/Objectives	Research Methodology
	value stream mapping for design and analysis of the ED. Results showed improvement in both waiting time and service level.		
Zanin, et al. (2011)	Aimed to improve patient experience in ED, improve medical overload, reduce wait time. Used a combination of Lean tools and simulation to analyze, assess, improve the process.	Patient LOS ED process	Qualitative (case study)
Mari, et al. (2008)	Aimed to improve the performance of different factors in ED by using Lean. Used Delphi method and design of experiment (DOE) method. Relied on the Dynamic Reconfigurable System concept and external fast truck instead of internal fast truck. Achieved reduction in waiting time and throughput time.	Patient LOS Laboratory	Mixed methods (qualitative, quantitative)
Awaad (2018)	Utilized Lean principles and Kaizen tools to optimize patient transfer process instigating in the ED. Ran many experiments to identify efficiency of process and accuracy of handoff. Results showed reduction in number of handoffs, elimination of non-value added, increased patient safety.	Patient LOS Patient safety	Qualitative (case study)
Al Owad, et al. (2018)	Used Lean principle to improve the waiting time in the ED. Developed discrete-event simulation to redesign the existing ED based on various inputs (hospital data, survey, interview). Results showed the reduction in wait time by 61% and patient LOS of 34%.	Patient LOS	Mixed methods (qualitative, quantitative)
Hossam (2018)	Aimed to use Lean-based interventions to address ED overcrowding issues. Collected patient flow data to determine the major causes of overcrowding and increased patient LOS. Results showed Lean management as suitable approach for improving overcrowding by reducing waste.	ED overcrowding Patient LOS	Quantitative (observation)

Author/Year	Summary	Improved Measures/ Objectives	Research Methodology
Al najem, et al. (2019)	Developed a framework to evaluate Lean within ED. Identified six main categories of the essential factors for Lean implementation.	/	Qualitative (framework)
Cunningham, et al. (2018)	Used Lean management methods to address multiple issues in ED (patient LOS, ED overcrowding, laboratory turnaround time). Determined effectiveness of applying Lean for improving ED process.	Patient LOS Laboratory turnaround time	Qualitative (systematic search)

Although all of these studies used the Lean approach to improve processes in the emergency department (ED), the measures and objectives varied. Among the various improved measures, the patient length of stay (LOS) and the overall process flow in EDs were targeted by these studies. Other factors measured for improvement included: job satisfaction and staff management, medical errors, patient satisfaction, patient safety and laboratory turnaround. Most of these focus on reducing the time of processes done in the Emergency Departments.

The study of Mari (2008) on the improvement of patient LOS by relying on a dynamic reconfigurable system concept and external fast truck instead of internal fast truck, is the earliest study in the results used the Lean for measuring and improving overall patient LOS. Mari (2008) found out that the Lean approach can reduce the waiting time and throughput time as well. This means that since 2008, Lean has been demonstrated to be an effective continuous improvement tools to reduce patient LOS, especially in Emergency Departments.

More recent studies such as by Improtta (2018), Cunningham (2018), Hossam (2018), Al Owad (2018), and Awaad (2018), all agreed that the use of Lean management increases the

performance of the ED while decreasing the patient waiting time; Al Owad (2018) even noted that Lean management can reduce waiting time by 61% and patient LOS by 34% in the Emergency Department. Aside from this, the researchers were also able to identify the reasons why patients stay longer in the ED and, through Lean practices, they were able to give recommendations on how to fix these problems. Some of the causes named were overcrowding and wastes. The main strength of Lean management and its greatest contribution, therefore, is that over time, researchers were able to prove its effectiveness as a continuous improvement tool especially in reducing the LOS of the patients and improving the performance of the Emergency Departments.

Other notable study is the use of lean tools in reducing medical errors. Meyer (2010) adopted the lean performance improvement technique in order to give better care services, specifically at the Denver Health Hospital. Through this study, the ED was able to adopt the system of patient fast-tracking to reduce patient LOS and also to avoid medical errors. This case study is notable because it is unique as compared with others that focused more on patient LOS and other ED processes. Meyer (2010) investigated the contribution of Lean management for solving medical errors and their results showed that the Lean is also effective in reducing medical errors in the ED.

Lean management was not only used to improve overall patient experience in the ED but also for staff management, job satisfaction, and staff assignment. For example, in the study of Teng-Kuan (2015), the researchers used the Lean principle and simulation optimization to improve the layout design of the ED and the issues from staff assignment. In concluding this study, it was found that Lean was able to improve the service level of the ED with the right staff assignments, which ultimately lead to the reduction of waiting time as well for the patients. These results showed

that when the ED staff are assigned well, Lean can help in reducing the time that patients would have to stay in the department.

4.5.2 Six Sigma Studies

Implementations of Six Sigma generally focuses on efficiency, cost reduction, increase profitability, and improved quality. The effective implementation of Six Sigma to improve emergency departments performance is shown in multiple studies. Table 4.4 shows numerous studies applied Six Sigma to enhance the triage process, reduce patient LOS, and increase patient satisfaction. Only four studies included in the literature applied Six Sigma.

Table 4.4 A summary of studies using Six Sigma

Author/Year	Details of work done	Improved Measures	Research Methodology
Hussein et al. (2017)	Used integration of Six Sigma methodology and discrete event simulation (DES) to improve ED. Aimed for reduction overcrowding in EDs, reduction of patient LOS, improvement of patient satisfaction with focus on medical equipment utilization. Used Six Sigma methodology based on DMAIC format to analyze ED overcrowding issue.	Patient LOS Patient Satisfaction	Qualitative (case study)
Mandahawi, et al. (2017)	Developed a discrete-event simulation model to redesign the existing ED based upon inputs: staff survey, historical data, and interviews. Performed the simulation study as a part of design for Six Sigma (DFSS) project to create planned triage process. Results indicated reduction of patient LOS by 34%.	Patient LOS Triage Process	Qualitative (case study)

Author/Year	Details of work done	Improved Measures	Research Methodology
Majid, et al. (2013)	Examined waiting time of non-critical patient in ED using six sigma approach. Applied five phases on DMAIC and different tools (survey, root cause analysis) to solve process issues. Results showed reduction in waiting time in ED.	Patient LOS	Mixed methods (qualitative, quantitative)
Taner, et al. (2009)	Presented the application of Six Sigma on high turnover issue in medical emergency services and paramedic backup. Applied DMAIC tool for reducing turnover rate of doctors in ED. Applied some statistical methods: ANOVA, regression for data analysis. Results indicated improvement in organization's initiatives to doctors' working conditions, improvement in sigma level of process	ED process	Mixed methods (qualitative, quantitative)

Six Sigma studies are less common compared with the studies identified for Lean management and this may mean that Lean principles as a continuous improvement tool are more widely used as compared to Six Sigma. Nevertheless, like lean, six sigma is studied most often for the improvement of patient LOS. Out of the four studies that used six sigma, three of them measured the improvement of patient length of stay while other topics included patient satisfaction, triage process flow, and emergency department process.

As for patient LOS, the three studies all provided evidence that Six Sigma can reduce the overall length of stay and waiting time of patients among the included emergency departments in their studies (Hussein, 2017; Mandahawi, 2017; Majid, 2013). Even though three studies arrived at the same conclusion, their methodologies were different. Both Hussein (2017) and Majid (2013) applied the five phases of the DMAIC, while Mandahawi (2017) used the Design for Six Sigma (DFSS). Hussein (2017) specifically focused on analyzing the overcrowding issue while Majid

(2013) focused on the process issues in the ED. Lastly, Mandahawi (2017) focused more on creating a planned triage process to reduce patient LOS. The strength of Six Sigma is apparent given that, even though they used different Six Sigma methodologies, they all came to a unified conclusion. In addition, these studies showed that six sigma methodologies are flexible enough to be used in the ED processes and reducing patient LOS.

The fourth study that used Six Sigma was focused more on the use of the tool on high turnover in the medical emergency services and paramedic backup. Unlike the previous studies discussed, this study is notable for going beyond the usual issue of patient LOS and focused on another important aspect of the ED processes. Taner (2009) used the DMAIC tool for reducing the turnover rate of doctors in ED. Through the use of statistical methods such as ANOVA and regression for data analysis. Significantly, as a result of the organization's initiatives the working conditions of doctors were improved. Moreover, this mixed-methods study was able to improve the sigma level of this process in the ED. This study shows that Six Sigma principles are also effective in handling issues with regards to the employees or staff of the ED.

The main weakness of six sigma is that there is a scarcity of studies conducted on its application in EDs. On the other hand, the strength of Six Sigma is that its results are similar to Lean management suggesting that Six Sigma is likely to be effective in this context. This also may have contributed to the emergence of Lean Six Sigma, which as the combination of these two continuous improvement tools is likely to lead to a more effective principle of management.

4.5.3 Lean Six Sigma Studies

Lean Six Sigma is a powerful quality improvement tool. It has been used in both industry and healthcare sectors to meet the expectations and needs of customers/patients, improve quality, eliminate waste, and improve profitability and cash flow. Lean Six Sigma can be implemented in various departments based on healthcare organizations to improve laboratory, treatment, nursing, radiology, and managerial and technical services. Table 4.5 shows numerous studies that applied Lean Six Sigma to improve different processes in the ED; 13 studies applied this approach.

Table 4.5 A summary of studies using Lean Six Sigma

Author/Year	Details of work	Improved Measures	Research Methodology
Johnson, et al. (2004)	Focused on Process Improvement (Six Sigma and Lean) and Computer Simulation study. Used improvement format of Six Sigma methodology to define, measure, analyze, improve, control (DMAIC), re-engineer critical processes within ED.	Patient LOS Process errors	Qualitative (case study)
Tetty, et al. (2016)	Recommended use of DMAIC process to achieve efficient process outcome in inventory management system. Applying such a process helpful to redesign cart storage system and gain essential benefits regarding inventory items and expired products in ED.	Inventory management of the ED	Qualitative (case study)
Blick (2013)	Applied Lean Six Sigma to provide better care services, reduce patient LOS, and achieve better laboratory return on investment. Results showed that effectiveness of laboratory services impacted patient LOS positively in ED.	Patient LOS laboratory	Qualitative (case study)

Author/Year	Details of work	Improved Measures	Research Methodology
Sanders & Karr (2015)	Applied Lean Six Sigma tools to reduce turnaround time in ED. DMAIC process used to eliminate waste. Results showed reduction percentages in different factors of TAT.	Turnaround time (TAT) for the ED	Qualitative (case study)
Leggat, et al. (2016)	Implemented Lean Six Sigma to redesign process and investigate role of workforce in implementing such a method. In-depth interview conducted with participating ED staff. Concluded evidence of relationships between implementation of process redesign and supporting management practices.	ED staff Process Flow	Qualitative (case study)
Bisgaard, et al. (2009)	Used application of Lean Six Sigma to study specific case on reducing patient length of stay with chronic obstructive pulmonary disease. Statistical methods used: analysis of variance (ANOVA) and Pareto analysis. Results showed improvements in quality and reduction in costs.	Patient LOS	Mixed methods (quantitative, qualitative)
Laureani, et al. (2013)	Provided useful information for physicians who are using Lean Six Sigma approach in hospital setting. Established that Lean Six Sigma can be applied and provide advantage in variety of settings within hospital.	Process Flow	Qualitative (case study)
Furterer (2018)	Applied Lean Six Sigma DMAIC methodology to improve throughput. Confirmed application of Lean Six Sigma approach could improve processes of healthcare. Results showed reduction of patients' length of stay by 30% in three months and patient satisfaction increased by 24% to 89.9%.	Patient LOS Patient Flow	Mixed methods (qualitative, quantitative)
Wolf (2009)	Adapted Lean Six Sigma technique to streamline and improve inpatient discharge planning process in ED. Used different Lean tools and available technology. Results showed reduction in patient discharged by 40%, reduction in	Patient LOS Patient satisfaction	Qualitative (case study)

Author/Year	Details of work	Improved Measures	Research Methodology
	patient disposition by 20%, increased in patient satisfaction.		
Bancroft, et al. (2018)	Examined England's Accident and Emergency Arm of the National Health Service (NHS). Considered positive impact from implementing LSS to improve quality and reliability of services. Obtained independent variable average monthly temperature data and analyzed patient volume with dependent variable. Achieved significant improvement in productivity, cost reduction, patient care.	Patient service	Mixed methods (qualitative, quantitative)
Al Owad, et al. (2013)		Patient flow Patient satisfaction	Mixed methods (qualitative, quantitative)
Mozammel, et al. (2011)	Developed systematic approach through integration of both Six Sigma and Lean to improve patient flow in ED for comprehensive conceptual framework of LSS. Results of conducted survey indicated most improved variable affecting patient satisfaction with patient flow including layout of ED, waiting time, and effectiveness of system.	Process flow	Qualitative (case study)
Stanton, et al. (2014)	Utilized LSS to reduce variability and waste. Created baseline metric of existing process, collected, analyzed data to improve work efficiency of workload.	Patient flow ED staff	Qualitative (case study)

The results showed that Lean Six Sigma studies are relatively more common as compared with Six Sigma alone and that the leading measurement of improvement is the same as with Lean and Six Sigma (i.e., patient LOS). This is followed by the overall process flow in the emergency

department, which can contribute as well to the length of stay needed for the patients. Other measures of improvement studied included: patient satisfaction, patient service, and staff management. The most unique measure that is not present both in the list of studies for Lean and Six Sigma, is the inventory management. Though process errors sound different; it has the same idea as medical errors included in the study for Lean principles.

Effective laboratory services were also shown to reduce patient LOS (Blick, 2013), and most studies used the DMAIC methodology for their studies. According to Futerer (2018), there is a 30% reduction on patient LOS through the use of the DMAIC, while (Wolf, 2009) concluded that the reduction of LOS positively affects and increases patient satisfaction.

Regarding the process flow, these studies found that the use of Lean Six Sigma can improve work efficiency of workload (Mozammel, 2011), provide advantage in various settings of the hospital (Laureani, 2013), and improve implementation of process and management practices (Leggat, 2016). Overall, the results of these studies suggest that Lean Six Sigma is effective in improving the process flow not just in the ED but in hospitals or various settings in general.

As noted earlier, Tettey (2016) is unique because the improved measure was not present in either the Lean or Six Sigma group. The study used the DMAIC process and recommended it in order to achieve efficient process outcome in inventory management system in the ED. Significantly, Tettey (2016) noted that applying the DMAIC process is helpful in redesigning a cart storage system and gains essential benefits related to inventory items and expired products in the ED. Interestingly, Tettey (2016) did not connect the case study to patient LOS or other staff management issues and medical errors.

Even though the number of LSS studies is fewer than for Lean, these studies are more far reaching with broader scope and impacts including measuring factors that are not measured by lean or Six Sigma alone. It can, therefore, be considered that the combination of these two continuous improvement tools is likely to produce better results. The major contribution, therefore, of Lean Six Sigma is that it can be used more flexibly in various hospital settings and on different issues.

4.6 Results and Discussion

Emergency departments have experienced significant disturbances due to changes in patients' expectations and needs, and an increase in healthcare expenses (Albar, 2016). These disturbances have made essential issues that must be solved for patients and emergency departments to ensure that they can provide effective and efficient services (Hussein, 2017; Liberator, 2012). A series of advantages can be drawn from improving the processes in the ED, such as avoiding medical errors, reducing costs, increasing the productivity of operations, and improving the quality of care services for patients (Laureany et al., 2013; Yadav & Desai, 2016).

Since 2004, hospitals have been implementing Six Sigma, followed by Lean; as these tools proved to be effective to improve the quality of healthcare services (Buell, 2010). Some hospitals are using a combination of both tools (i.e., Lean Six Sigma). In the healthcare industry, Lean Six Sigma projects have focused on administrative support, direct care delivery, and financial administration (Antony et al., 2006). The goal has been to identify and eliminate waste from patient pathways, to improve clinical processes, to increase efficiency, safety, and quality, and to enable workers to examine their workplace (Johnson et al., 2004; Wang et al., 2015; Leggat et al., 2016).

Additionally, such tools were applied in different departments of the hospital such as emergency rooms, critical care, laboratory, and diagnostic imaging (Hitti et al., 2017; Tettey et al., 2016; Mandahawi et al., 2017). There are great results in terms reduced patient waiting time, admission time, decrease medical errors, decrease mortality rate, improve processing time, improve the quality of care services, and increase patient satisfaction (Hitti et al., 2017; Tettey et al., 2016; Johnson et al., 2004; Buell, 2010).

Implementation of CI tools requires the participation of top management and staff in order to make the necessary improvements or changes (Padhy, 2017; Wang et al., 2012). Despite the effective implementation of Lean Six Sigma in emergency departments, some healthcare organizations have concerns about the execution process as well as concerns of change in organizational culture and failure to recognize the need for change; as it could put a great burden on them (Herbert, 2008). In addition, the application of Lean Six Sigma should focus on using the tools based on the goals, needs, and structure of organization. Hence, Lean Six Sigma should be implemented only if necessary, in order to avoid waste (Herbert, 2008; Hitti et al., 2017).

This study investigated studies related to CI tools used to improve processes in the ED. The results of the systematic literature review show that 40 papers have been selected to be analyzed for this study. It is apparent from Figure 3 that there has been some work in CI tools implementation conducted between 2014 and 2019. Figure 4.4 indicates that most of the works of CI tools application followed the qualitative method, while little works followed other methodologies such as quantitative and mixed methods. It could be noted that, from Figure 4.5, the applications of Lean Six Sigma in emergency departments are very limited; only thirteen

studies out of 40 have selected. This result indicates a great opportunity for Lean Six Sigma to be implemented in the ED based on hospitals.

This review was conducted to find journal articles related to the use of quality improvement tools being used to improve emergency departments, as well as measures being improved. Based on the literature survey, the most commonly improved measures are patient LOS and the patient process flow as shown in Figure 4.8. Increase the demand in the ED with limited resources is causing the increasing patient LOS (Hussein et al., 2017; Albar, 2016). The ACEP stated that ED crowding occurs when the demand for emergency services exceeds available resources (Lin et al., 2011). ED crowding is strongly caused by patient Length of Stay (LOS), which is an essential factor in health care (Buack and Almis, 2017; Chen and Wang, 2016; Albar, 2016). Patient LOS impacts patient satisfaction, patient safety, clinical care outcomes, as well as the reputation of healthcare organizations (Parker and Marco, 2014).

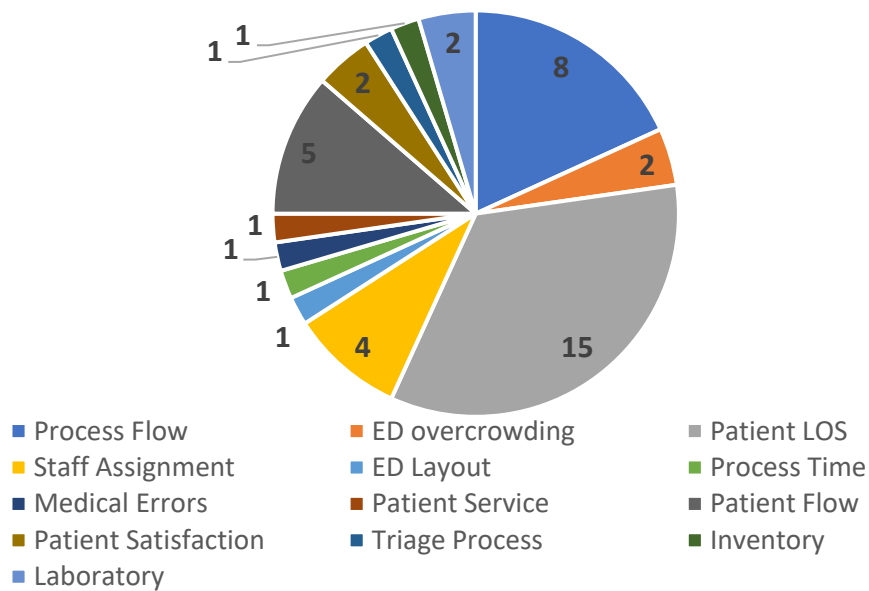


Figure 4.8 Improved Measures in Emergency Departments

The purpose of this SLR was to identify and thoroughly review existing knowledge, literature patterns, and variables in this research area. Future research could utilize this knowledge to develop a conceptual model from factors synthesized from the literature as well as allows scientists and researchers to view the current evidence in a particular area that can contribute to evidence-based practice. The systematic literature review technique aims to conduct a methodical, comprehensive review, targeting the most relevant studies that address continuous improvement tools in emergency department (Mulrow, 1997; Tranfield, 2003). Bibliometrics analysis is the application of quantitative analysis and statistics to analyze the publications that provide the information for evaluating the developments in the research area (De Bellis, 2009).

4.7 Conclusion

Aiming to not only bear the market segments observed competitive advantage, it is also the supreme goal of quality improvement in the healthcare industry to meet the needs and demands of every patient. In order to improve patient satisfaction, reduce the costs, offer high-quality service and increase efficiency, several healthcare organizations have applied different tools such as continuous improvement and quality management tools (Furterer, 2018; Hussein, 2017; Laureani, 2013). Demonstrating a wide array with a shared challenge of attaining a higher level of quality, implementing such kinds of tools is evidently essential especially in emergency departments (ED). In this study, the researchers were able to evaluate some of the most integral tools used in manufacturing industries that helped their performance become more competitive and efficient. The same tools were also observed to have shown the same capabilities when it

comes to improving health-related issues that needs improvement as well. In providing the review of the 40 unique and relevant studies, there were several areas to determine how the CI tools have been effective based on the three factors. Even though the researchers were able to display different areas to consider in order to determine the effectiveness of the tools over the years, there are still some gaps observed.

The short amount of studies included in the review of the study can be considered as a gap as to how it can create a less credible findings or analysis of how the changes are observed. For instance, analyzing the publication per year has shown how there are several factors that can be involved in the decrease or increase of publication. However, the number of prevalence still does not holistically prove that it means the study is non-essential or irrelevant. There are some studies that are published alone in a particular year but still carries that very valuable role in the society. If the number of studies involved in the review could have been increased, then it could be better for the study to gain such credibility and robustness in conducting such type of review.

In aiming to determine the effectiveness of the CI tools in emergency departments' performance, there should be a given holistic approach when it comes to determining the coverage of the implementation of these tools. Considering that this is a systematic review, it may provide a much more shallow perspective on how the tools and ED are correlated. However, if the researchers would aim to determine real-time or current performance of such tools in the current situations, we observe today in emergency departments, then the study could have provided a much more profound and credible analysis with how these tools play its role in improving ED processes. Although this is considered as a gap, this may also be a way for the future researchers to find possible options and strategies on how another study can provide a much more formal and holistic

approach when it comes to determining their effectiveness in improving the healthcare industry. Overall, the study provided a creative way of determining the effectiveness of CI tools on the performance of the emergency department in a sense that it also opened a way for the needs of this department to be determined, thereby already seeing a higher probability of its performance to really change in the next years.

4.7.1 Limitations

As in all studies, there are some limitations inherent to the SLR technique. The first limitation related to reviewing searched title and abstract only in the first phase, which could lead to missing some relevant studies. In addition, due to the vast amount of studies related to quality healthcare, the probability of missing some related studies during the review process is also high. In addition, this review limited to 40 journal articles sourced from a single database using a limited number of specific keywords. To the extent of the author's knowledge, the list of keywords used in this study is taken from the scope of the study. However, there might be other keywords used by other studies that are not covered in this review. Another limitation is regarding the search time limit. Searching for a specific topic and reviewing numerous articles under real-time could increase the probability of eliminating relevant articles. Due to the limited number of studies and irregularity of methodological approaches, the findings were often incomparable and broad.

4.7.2 Future Work

Conducting a comprehensive literature analysis provide opportunities for future work and, as noted in the review, most of the works to improve emergency departments are carried out on

implementing Lean methodology to improve process flow, patient satisfaction, inventory, ED overcrowding, and patient LOS. Numerous researchers have studied Lean Six Sigma in manufacturing (Hassan, 2013; Hossain, 2015; Alcaide-Muñoz & Gutierrez-Gutierrez, 2017; Sreedharan & Raju, 2016; Prashant & Sandeep, 2017) and service industries (Deniz, 2017; Leone & Rahn, 2010; Laureani et al., 2013; Loubnan, 2018). The results of those studies show a vast amount of improvement in the systems. On the other hand, the use of Lean Six Sigma in ED is very limited; 33% papers used the approach in emergency department. For that reason, this work can be expanded by utilizing the results of this review to support the development of a conceptual framework of successful factors of Lean Six Sigma implementation in ED including the positive outcomes.

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CHAPTER 5: CONCEPTUAL FRAMEWORK

A Conceptual Framework for Critical Success Factors of Lean Six Sigma in Emergency Departments

Note: This chapter is the first manuscript of this dissertation and an appropriately formatted version is planned to be submitted to *Total Quality Management* (IF=1.47) on July 31, 2020.

5.1 Abstract

Purpose - The purpose of this paper is to investigate and analyze the critical success factors (CSFs) of Lean Six Sigma (LSS) implementation in emergency health care and develop a conceptual framework to guide future work.

Design/methodology/approach - A Content Analysis is used to review the comprehensive CSFs of LSS implementation literature to summarize its current and past trends. Several dimensions of the literature review were analyzed including year of publication, country of study, quality initiatives, methodology, sector type, and journal name.

Findings - Based on seven papers from different countries (Australia, Malaysia, U.K., Singapore, and India), the ranks and importance of 36 CSFs of LSS implementation in healthcare are analyzed and compared. The ten most important CSFs have been identified.

Research limitations/implications - The study is relevant regarding the CSFs for successful implementation of LSS in ED and provides a framework for healthcare organizations for implementation of LSS successfully and achieving intended outcomes.

Originality/value - The study provides an integrative review that synthesizes current evidence in best practices for implementing LSS in ED. In addition, this study compares these results to similar research areas to investigate boarder phenomena.

Keywords Lean Six Sigma, critical success factors, Content Analysis, conceptual framework, emergency department

5.2 Introduction

Emergency departments in hospitals face major challenges when it comes to delivering high quality, safe, and well-timed patient care associated with the ever-existing background of growing patient numbers while dealing with inadequate hospital resources (Johnston et al., 2016; Mandahawi et al., 2017; Raziq et al., 2015). This results in a disparity between the increasing the number of patients and the capacity of the emergency departments to deliver care as well as a lack of adequate flow of the patients in the process and overcrowding of emergency departments (Furterer 2018; Johnston 2016). For this reason, several researchers, including the current study, found a possible way to improve this by creating a conceptual framework for critical success factors of Lean Six Sigma in healthcare (Ahmed et al., 2018; Laureani and Antony, 2012; Zhang et al., 2016).

This study provides theoretical fundamentals to provide a clearer and wider understanding of the main topics involved; such as the critical success factors, Lean Six Sigma, and the role of emergency departments in society. In the current study, the research was able to highlight the need to assess the most basic definition of Lean Six Sigma approach involved, as well as to provide the most importance CSFs that support the implementation within the emergency departments. With this in mind, the objective of this study is to review the CSFs of LSS implementation in the ED. For this purpose, a Content Analysis will be conducted to provide the most relevant and credible information that will be essential in providing the best approach to the problem. In addition, the comparative analysis of the individual CSFs in healthcare will be discussed based on their ranks and importance. Furthermore, a conceptual framework will be developed based on the ten most commonly studied CSFs of LSS implementation in various healthcare organizations and how this has been used or applied by several organizations and/or researchers who have conducted the most reliable and relevant studies.

To achieve the proposed objective, this study is designed in the following sections. First, an overview of the literature will be discussed. Second, a description of the research methodology will be presented and followed by a descriptive analysis of the findings. Then the results and discussion will be discussed with inclusion of a detailed discussion of the most important ten CSFs of LSS implementation. Next, a summary of the existing literature regarding the conceptual framework of LSS will be reviewed along with the conceptual framework of LSS in EDs. Last, the conclusion and future work will be presented.

5.3 Background

Lean is widely recognized as a systematic method that can diminish or remove activities that do not add value to the process (Bhat & Antony, 2019). It highlights the eliminating wasteful stages and accepting the value-added stages in the process. This particular method is known to guarantee customer satisfaction while providing a high standard in product improvement or service delivery time, reducing the process cycle time, lowering the inventory levels, or reducing or removing defects enhancing the resources for main improvements. (Rastogi, 2018). Six Sigma is known as a data-driven problem-solving method in which the focus is to provide process distinctions and customer satisfaction using lean methods (Rastogi, 2018). These two methods were known to have been combined and thereby now known as Lean Six Sigma.

Lean Six Sigma is defined as a data-driven and fact-based philosophy that puts value on defect prevention than defect identification (Bhat & Antony, 2019; Muraliraj et al., 2017; Rastogi, 2018). It helps organizations attain operational performance goals and enhance customer satisfaction by reducing waste, variation, and phase period while encouraging work standardization application (Yadav et al., 2018). This quickly growing method combines the methods, principles, and tools of both lean and Six Sigma methods into one powerful approach for improving the operations of an organization (Muraliraj et al., 2017; Yadav et al., 2018). The Lean Six Sigma approach has been viewed as a team-oriented approach and got its roots in the United States in the 1980s as an assimilation of management principles and processes that had been initiated in Japan (Hines and Lethbridge, 2008; Womack & Jones, 1996). The aim of American

managers was to compete with the products made in Japan which used both Lean and Six Sigma approach in the manufacturing process (Kenton, 2018).

5.3.1 Lean Six Sigma in healthcare

Healthcare requires effective strategies in order to deliver the most efficient care to people while remaining in a competitive position by remaining cost-effective and innovative in their practices (Azzam et al., 2012). Since Lean Six Sigma has been given much attention due to its efficiency in quality management, the application of this technique has spread and reached the healthcare industry with some of the application of the Lean Six Sigma being introduced into its systems (Koning et al., 2006). First is the reduction of complexity in hiring personnel by the introduction of a department standardized worksheet, centralization of requests for temporary personnel, reduction of the number of temporary agencies, and introduction of a new administrative system for the checking invoices. Second is the reduction of the operating theater start times by analyzing the factors that are affected by the start time and the usage of the Lean Six Sigma tools in order to manage the operational processes and the designing of a new admissions process based on the simple principles aligned with Lean Six Sigma technique.

Another application is through the maintenance processes. After analyzing the situation of the maintenance team, the Lean Six Sigma tools were applied in order to improve the standard operating procedure, work planning system, and the performance monitoring and visual management (Hilton & Sohal, 2012; Yadav et al., 2018). The application of the Lean Six Sigma in healthcare is not limited to these issues but these still prove the fact that it is really possible to

and even ideal to apply it in the healthcare industry in order to improve the services and reduce costs and wastes (Ahmed, 2018; Koning et al., 2006; Zhang et al., 2016). It is true that if the healthcare services are inefficient, they are more likely to cost more and only a few would benefit from the innovative advancements in the healthcare industry (Koning et al., 2006). Therefore, lean six sigma practices should be very much welcomed in the processes and services of the healthcare industry (Zhang et al., 2016).

5.3.2 Lean Six Sigma in emergency departments

Lean Six Sigma technique has been adopted in the healthcare within its emergency department. Researchers have proven recently that by applying Lean Six Sigma practices in the hospital's emergency department length of stay of patients can be reduced (Furterer, 2018; Mandahawi et al., 2017). In a recent research by Furterer (2018), the Lean Six Sigma DMAIC methodology was applied in order to reduce patient's length of stay by 30% in just three months and reducing the percent of patients leaving without treatment from 6.5% to 0.3%.

Furterer (2018) went through all the DMAIC process in applying the Lean Six Sigma technique, making sure that every step is followed as the researcher acted as the project and team facilitator as well as the Lean Six Sigma Master Black Belt mentor for the team. After completing the whole process, the results showed that even though the whole process is really taking a lot of time before getting the results, the study was done successfully and the researcher was able to achieve the goals that they set before the application of Lean Six Sigma. Moreover, after the research and processes were completed, patient satisfaction was measured, and it had increased

from 24% before the application to 89.9% which was a huge increase for the hospital (Furterer, 2018).

As noted earlier, hospitals are also in need of strategies and techniques that would make them more effective in improving their performance, cost-efficient, and competitive. The application of Lean Six Sigma in the emergency department and its success proves how much the technique can improve processes and services of the healthcare industry (Furterer, 2018; Hussein et al., 2017; Tetty et al., 2016). Although there are many claims of the effectiveness of LSS (Hwang et al., 2014; Mazzocato et al., 2010), some researchers have argued that the implementation of LSS has not been without challenges and barriers (Antony et al., 2007; Chakrabarty & Tan, 2007; Matchette, 2006).

5.3.3 Challenges of Lean Six Sigma in healthcare

Applying Lean Six Sigma in healthcare is not easy, even the application of the technique to the ED was challenging. It can be very challenging to apply Lean Six Sigma to the entire services and processes in the hospital (Jeyaraman and Teo, 2010; Uppal et al., 2012). Researchers are also investigating the challenges and opportunities of the Lean Six Sigma in health operations (Hitti et al., 2017; Jeyaraman and Teo, 2010; Lee and Chang, 2010; Snee, 2010; Uppal et al., 2012). When it comes to the opportunities, most researchers believed that the Lean Six Sigma is able to improve the industry in many ways with facing some challenges. (Hitti et al., 2017; Uppal et al., 2012).

One of the main challenges of Lean Six Sigma in healthcare is the fact that there is a lack of an accurate and holistic approach that can be used for the entire hospital operations (Jeyaraman

and Teo, 2010; Lee and Chang, 2010; Snee, 2010). Another challenge is that the hospital management boards, policy makers, funding agencies and grants may not be ready or have not established ways to innovate and redefine healthcare tools in order to design and implement Lean Six Sigma in healthcare (Aboelmaged, 2010; Yaduvanshi and Sharma, 2017). Common challenges include lack of management support, lack of resources, resistance to change, insufficient training, and lack of understanding of the implementation rationale (Jeyaraman and Teo, 2010; Kwak & Anbari, 2006; Lee and Chang, 2010; Snee, 2010). Basically, even though the industry knows the positive impact and benefits of the Lean Six Sigma, the real challenge is to prepare for the introduction of the concepts into the healthcare services and processes (Yaduvanshi and Sharma, 2017).

5.4 Research Methodology

Li and Cavusgil (1995) suggested three ways to examine the current state of knowledge in this field study. These ways include Delphi method, meta-analysis, and Content Analysis. A Content Analysis is defined as “a technique to manifest the content of literature in a systematic, qualitative and quantitative fashion” (Muraliraj et al., 2017). This approach was first used in analyzing magazine articles, newspapers, political speeches, and advertisements in the nineteenth century (Harwood and Garry, 2003). Ibrahim et al. (2015) presented three critical steps to conduct a Content Analysis: analysis of articles, content definition within each category, and identification of literature review gaps. Figure 5.1 summarizes the Content Analysis process conducted in this study.

The research started with searching for relevant articles of CSFs of Lean Six Sigma in academic journals. The search concentrates on journals in the areas of quality management, process improvement, quality initiatives, and quality healthcare. The time horizon of the study is from 2008 to 2019 in order to study the previous decade of progress to support the findings and conclusions. Moreover, this time frame contains the period of time in which use of the ED has increased driving the need for CI tools in this area. This approach provides the most recent relevant information as needed for the Content Analysis. The following search terms were applied to identify the relevant studies: Lean Six Sigma, critical success factors, emergency department, and healthcare. In order to get a comprehensive overview about the research field, the relevant articles were reviewed and analyzed by taking into consideration the relevant articles for CSFs of LSS implementation regardless of the organization type, the quality initiatives, and the used methods. However, the initial results (1353 articles) still contained numerous irrelevant articles. After that, the goal focused on selecting articles that surveyed the CSFs of LSS, reviewing, and analyzing the content. Note that the in-depth discussion of the Systematic Literature Review and the selection criteria of publications was discussed in Chapter 4 and that this discussion is focused on the analysis of the selected publications for this chapter.

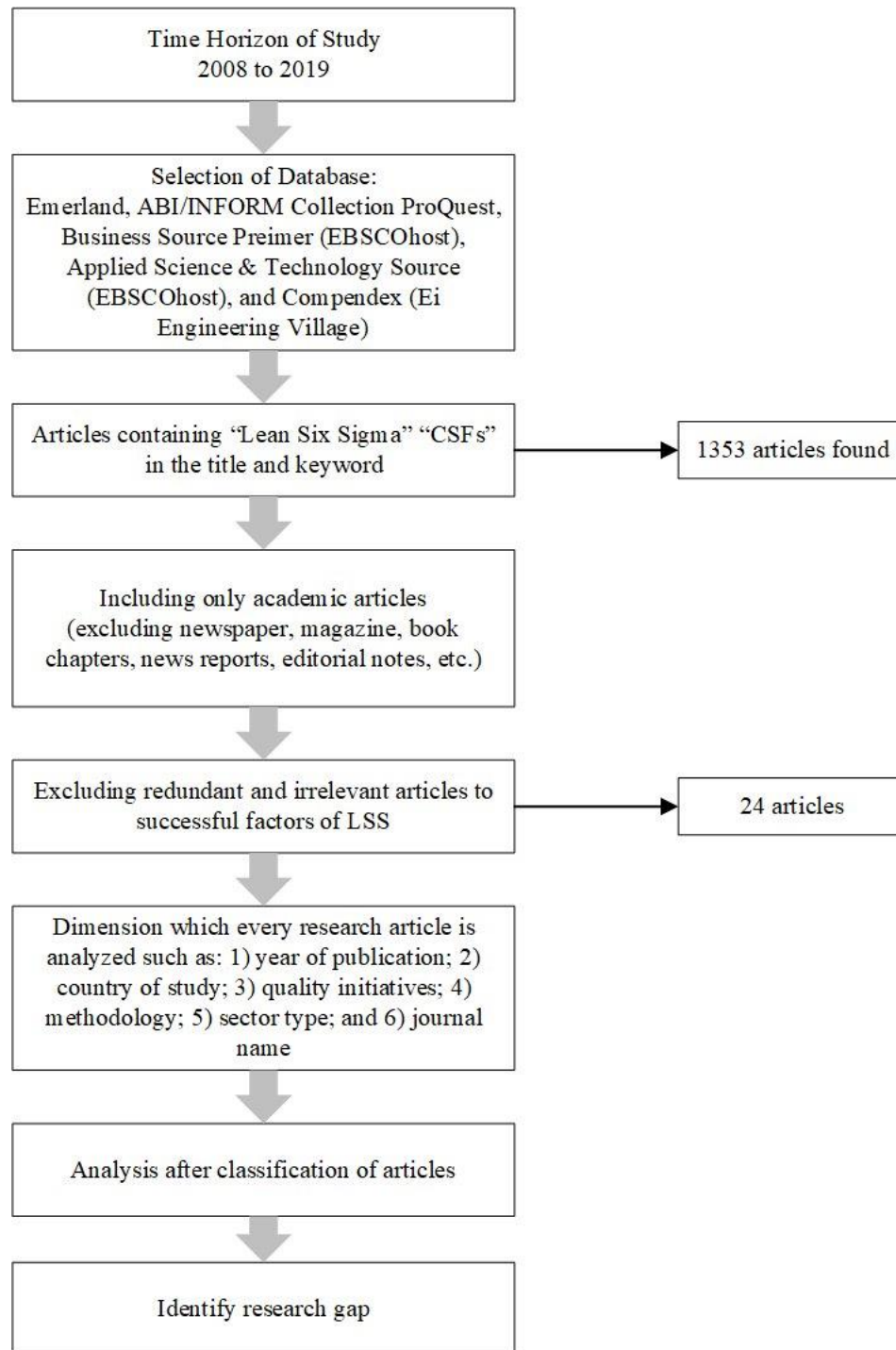


Figure 5.1 The Content Analysis process

This review focused only on academic journal papers, and therefore, the other article types were excluded in this study to attain a higher level of maturity concerning research area. The following databases were used to search for as many academic articles as possible: Emerald, ABI/INFORM Collection ProQuest, Business Source Premier (EBSCOhost), Applied Science & Technology Source (EBSCOhost), and Compendex (Ei Engineering Village). It cannot be guaranteed that this research is exhaustive; however, the selected and reviewed journal articles involve a reasonably comprehensive and representative body of the research regarding CSFs of LSS in healthcare. This is a good subset of sources as they index peer-reviewed articles that are relevant and are written by scholars, which increases the chances that the sources are credible and reliable. Further, these sources include research from a range of disciplines providing a more comprehensive review. Since this study follows Content Analysis, the selected articles were classified and analyzed based on six dimensions: year of publication, country of study, quality initiatives, methodology, sector type, and journal name. Thus, 24 articles were analyzed based on these dimensions, as summarized in Table 5.1.

Only articles using surveys were considered in this study to ensure that the evidence was empirical and to collect purposefully defined variables. (Ahmed et al., 2018; Hilton et al., 2008; Jeyaraman & Teo, 2010; Laureani & Antony, 2012; Manville et al., 2012; Mishra, 2018; Zhang et al., 2016). The excluded studies included non-empirical work, such as literature reviews (six articles), as well as research that did not contain purposefully defined variables or their results were specific to the research context including interviews (three articles) and a case study. The surveys have been to hospitals COEs and executives, middle management, senior management, workforce management, quality managers, and hospital staff (e.g. doctors, nurses, medical

laboratory technologists, and pharmacists). In addition, LSS experts were important participants in these seven surveys, the experts might have included Master Black Belts, Black Belts, and Green Belts, which are certifications managed by the American Society for Quality (ASQ). The respondents in these seven articles were asked to evaluate the level of importance as well as agreement or disagreement to assertions that the CSFs are essential for successful LSS implementation in healthcare. Some authors build a 5-point Likert Scale, while others relied on 6-point Likert Scale (e.g. 1-not at all important, 2- low important, 3- somewhat important, 4- moderately important, 5- very important, and 6- extremely important).

The next section will provide a detailed overview of the existing literature on CSFs of Lean Six Sigma implementation which consist of the 24 articles including the seven articles that used a survey as their methodology that were studied separately.

5.5 Descriptive Analysis

Twenty-four papers on CSFs of Lean Six Sigma implementation in industry, manufacturing, and healthcare have been published from 2008 to 2019. These studies conducted different methodologies such as literature reviews, interviews, and surveys. Six of these studies (25%) used qualitative methods while one article (4%) conducted multiple case studies to obtain a greater understanding of the use of LSS in healthcare. Fourteen studies (58%) conducted surveys using a quantitative method while three studies (12%) collected the data through a number of interviews. This shows the flexibility of the LSS as a topic of research throughout the years and that there are various ways to measure CSFs of LSS. Further, these numbers also mean that most of the studies on LSS are preferred to be through surveys and this could be related to how it is

easier to use measurements like Likert Scale to measure CSFs of LSS implementation. Due to this, existing survey items and constructs were also evaluated as part of the Content Analysis.

Regarding the healthcare sector, the first publication about CSFs for LSS in healthcare was published in 2008 by Hilton, Balla, and Sohal, while Gonzalez-Aleu, Van Aken, Cross, and Glover (2018) were the last authors who published in this area demonstrating that researchers have been active in this area throughout the years of study. Publications on CSFs of quality initiatives peaked in the years of 2012 and 2018 with a total of ten articles and five articles, respectively. This happened in line with the development of the healthcare sector. Most of the renowned journals in the field of quality management have published articles on LSS implementation in healthcare and the most common journal found in this review is the *International Journal of Lean Six Sigma* with six publications (25%) as indicated in table 5.1. Five articles (20%) were published in the *International Journal of Quality & Reliability Engineering*, while four articles (16%) were published in *TQM*. All other journals published only one article.

Table 5.1 Conducted studies about CSFs for LSS implementations

Author/Year	Country	Methodology	Sector	Journal
<i>Hilton, Balla, and Sohal (2008)</i>	Australia	Survey	Healthcare	The TQM Journal
<i>Heckl, Moormann, and Rosemann (2010)</i>	Germany	Survey	Service	Business Process Management Journal
Jeyaraman and Teo (2010)	Malaysia	Survey	Service	International Journal of Lean Six Sigma

Author/Year	Country	Methodology	Sector	Journal
<i>Hilton and Sohal (2012)</i>	Australia	Interview	Manufacturing	International Journal of Quality & Reliability Management
<i>Laureani and Antony (2012)</i>	UK	Survey	Healthcare Manufacturing	International Journal of Lean Six Sigma
<i>Manville, Greatbanks, and Parker (2012)</i>	UK	Survey	Healthcare	International Journal of Quality & Reliability Management
<i>Psychogios, Atanasovski, and Tsironis (2012)</i>	Greece	Interview	Service	International Journal of Quality & Reliability Management
<i>Sharma and Chetiya (2012)</i>	India	Literatura Review	Manufacturing	Asian Journal on Quality
<i>Naslund (2013)</i>	Sweden	Literatura Review	Healthcare Manufacturing	International Journal of Quality and Service Sciences
<i>Abu Baker, Subari, and Daril (2015)</i>	Malaysia	Literatura Review	Healthcare Manufacturing	International Journal of Lean Six Sigma
<i>Douglas, Douglas, and Ochieng (2015)</i>	East Africa	Survey	Manufacturing	The TQM Journal
<i>Psomas (2016)</i>	Greece	Survey	Manufacturing	The TQM Journal
<i>Zhang, Luo, Shi, Chia, and Sim (2016)</i>	Singapore	Survey	Healthcare Manufacturing	International Journal of Operations & Production Management

Author/Year	Country	Methodology	Sector	Journal
<i>Albliwi, Antony, Arshed, and Ghadge (2017)</i>	Saudi Arabia	Survey	Manufacturing	International Journal of Quality & Reliability Management
<i>Azyan, Pulakanam, and Pons (2017)</i>	Malaysia	Interview	Manufacturing	Journal of Manufacturing Technology Management
<i>Ahmed, Abd Manaf, and Islam (2018)</i>	Malaysia	Survey	Healthcare	International Journal of Health Care Quality Assurance
<i>Honda, Bernardo, Gerolamo, and Davis (2018)</i>	Brazil	Literature Review	Healthcare	Quality Management Journal
<i>Mishra (2018)</i>	India	Survey	Healthcare Manufacturing	International Journal of Lean Six Sigma
<i>Silva, Mergulhão, Favoretto, and Mendes (2018)</i>	Brazil	Survey	Manufacturing	International Journal of Lean Six Sigma
<i>Sreedharan, Vijaya, and Raju (2018)</i>	India	Literature Review	Healthcare Manufacturing	Benchmarking: An international Journal
<i>Antony, Forthun, Trakulsunti, Farrington, McFarlane, Bernnan, and Dempsey (2019)</i>	UK	Survey	Healthcare	Leadership in Health Services
<i>Bhat, Antony, and Cudney (2019)</i>	India	Case Study	Healthcare	International Journal of Quality &

Author/Year	Country	Methodology	Sector	Journal
				Reliability Management
<i>Gonzalez-aleu, Aken, Cross, and Glover (2019)</i>	US	Survey	Manufacturing	The TQM Journal
<i>Walter and Paladini (2019)</i>	Brazil	Literature Review	Manufacturing	International Journal of Lean Six Sigma

Studies on CSFs of Lean Six Sigma implementation were conducted in different countries. Most of the work was published in Malaysia and India with four articles (24%) per country followed by Australia and Greece with two each (8%) and three each (12%) for the U.K. and Brazil. One study (4%) was published for each of the following countries: Germany, Sweden, East Africa, Singapore, Saudi Arabia, and U.S.A. The studies about CSFs for quality initiatives were focusing on manufacturing in eight articles (33%) while studies on healthcare had seven articles (29%). Asian countries having more publication for LSS may suggest that these countries or researchers from these countries are more interested in the topic, while, on the other hand, Western countries appear to be less active in this area. Nevertheless, the variety of countries included also shows that LSS is deemed relevant for both Western and Eastern countries, whether they are developed or underdeveloped. The studies used various methods as described here to collect the data to identify the CSFs; as described previously, only seven studies (29%) conducted surveys on CSFs of LSS implementation in healthcare from 2008 to 2018 (Table 5.2).

In the U.K. Laureani and Antony (2012) focused on surveying 600 organizations (healthcare and manufacturing) to identify CSFs for continuous improvement initiatives with a

total of 101 respondents. Manville, Greatbanks, and Parker (2012) surveyed 200 managers for the same objective. Ahmed, Abd Manaf, and Islam (2018) focused on investigating the effect of workforce management and LSS on the hospital's quality. They distributed a survey to 673 staff in Malaysian hospitals including pharmacists, nurses, and doctors with a total of 335 respondents. In another study conducted in Malaysia, the top ten CSFs of successful LSS implementation were identified by Jeyaraman and Teo (2010). The other three studies were conducted in Australia, Singapore, and India. Zhang, Luo, Shi, Chia, and Sim (2016) conducted a survey among 410 organizations to identify factors affecting LSS in Singapore. Mishra (2018) prepared a framework of CSFs of LSS implementation in the Indian healthcare organization. Hilton, Balla, and Sohal (2008) conducted surveys to examine the relationship between the factors of the quality program and performance and to find the importance of the CSFs in hospitals in Australia. Jeyaraman and Teo (2010), Manville, Greatbanks, and Parker (2012), and Zhang, Luo, Shi, Chia, and Sim (2016) are the researchers who provided only the ranking of CSFs without using the importance factors. Studies by Laureani and Antony (2012), Hilton, Balla, and Sohal (2008), and Manville, Greatbanks, and Parker (2012) considered 20, 19, and 13 CSFs, which are the highest numbers of CSFs. The other four studies had 10 CSFs and less; Jeyaraman and Teo (2010) identify 10 CSFs for LSS implementation, Ahmed, Abd Manaf, and Islam (2018) identify nine CSFs in Malaysian hospitals, Zhang, Luo, Shi, Chia, and Sim (2016) identify six CSFs in Singapore, and Mishra (2018) identifies five CSFs in Indian organizations.

Table 5.2 Publications on CSFs for LSS implementation in healthcare

Author/Year	Country	Number of CSFs	Number of responses	Most important CSF
Hilton, Balla, and Sohal (2008)	Australia	19	-	Top Management Commitment
Jeyaraman and Teo (2010)	Malaysia	10	-	Top Management Commitment
Laureani and Antony (2012)	UK	19	101	Top Management Commitment
Manville, Greatbanks, and Parker (2012)	UK	13	-	Top Management Commitment
Zhang, Luo, Shi, Chia, and Sim (2016)	Singapore	6	32	Top Management Commitment
Ahmed, Abd Manaf, and Islam (2018)	Malaysia	9	335	Top Management Commitment
Mishra (2018)	India	5	35	Dedicated management and employee

5.6 Results and Discussion

In this study, only seven articles are identified from the existing literature review and are considered as related to CSFs of successful implementation of LSS in healthcare systems (Table 5.3). A total of 36 CSFs of LSS implementation were identified related surveying the healthcare organizations. This includes the ranks and importance of each factor as recognized in the seven selected articles.

Findings from Table 5.3 demonstrate the fact that “management commitment and involvement” is the most important CSFs of LSS implementation in healthcare. In addition, management commitment and involvement, training program and education, communication plan, project selection and prioritization, and linking LSS to customers are the most factors discussed in the most of studies. Studies by Hilton et al. (2008) and Ahmed et al. (2018) stated three different ranks and important factors for LSS tools and techniques.

The following six CSFs; technology infrastructure, competency of master black belt and black belt, establish LSS dashboard, benchmarking, and project tracking and review, were each identified once among studies. The CSFs, technology infrastructure, open organization, LSS knowledge, and zero defects, were identified only by Hilton et al. (2008), while the factor, project tracking and review, was identified by Laureani and Antony (2012). Additionally, the CSFs, competency of Master Black Belt and Black Belt, establish LSS dashboard, and benchmarking, were discussed only by Jeyaraman and Teo (2010). The next four CSFs, linking LSS to customers, workforce management, LSS tools and techniques, and best practice, were each identified in four studies (16%). The CSFs, financial infrastructure, LSS resources, facilitation, process improvement, workforce management, and measurement, were each discussed in two studies (8%). These results show that there are significant variations in the topics about LSS among the studies, further demonstrating the need for a Content Analysis and inductive synthesis of the variables.

The CSF, “organizational culture”, took the second rank in studies by Laureani and Antony (2012) and Zhang et al. (2016); the third rank in study by Jeyaraman and Teo (2010); and the twelfth rank in study by Gonzalez-aleu et al. (2018) with importance factor above 5. The factor of

“rewards and recognition system” ranked as the second to last and last place in two studies; however, it took the second rank in one study and was not identified by the other remaining studies. According to Jeyaraman and Teo (2010), some organizations apply reward and recognition systems on the success implementation of LSS. They have found that this motivates the employees to work on continuous improvement projects. They additionally indicated that the reward and recognition system should align with LSS objectives and goals to be more effective system.

In two studies, Hilton et al. (2008) and Laureani and Antony (2012), the CSF “Linking LSS to customers” was ranked between the third and seventh place with important factors 3.76 and 4.07. The study by Laureani and Antony (2012) identified 19 CSFs; the first seven ranks have importance factors higher than four while the last twelve ranks have less than 3 for important factors. The study by Hilton et al. (2008) has the same number of CSFs, 19, with noticeable change of the important factor. The second and fifteenth ranks achieved an important factor higher than 4, while the remaining ranks have important factors less than 3. It can be noted that most healthcare organizations pay little attention to the following CSFs: financial infrastructure, awareness, data availability/data trustworthiness, leadership style, and facilitation. “Linking LSS to business strategy” and “LSS resources” were evaluated each in two papers. “Linking LSS to business strategy” was found to be in the second and third place, while “LSS resources” had low ranks, 10 and 12. The important factors of the previous CSFs were inconsistent and mentioned in only two studies for each factors. The “leadership style” factor was identified only once and ranked as the fourth place. The next five CSFs; project management skills, LSS tools and techniques, best practice, organizational structure, and workforce management are ranked very inconsistently in the most of studies.

Table 5.3 Comparison of ranks and importance factors of CSFs.

Author/Year	Hilton et al. (2008)		Jeyaraman and Teo (2010)		Laureani and Antony (2012)		Manville et al. (2012)		Zhang et al. (2016)		Ahmed et al. (2018)		Mishra (2018)	
Management commitment and involvement	1	3.99	1	-	1	4.63	1	-	1	-	1	0.60	1	4.9
Training program & education	4	3.55	6	-	13	3.71	6	-	3	-	-	-	-	-
Organizational culture	-	-	3	-	2	4.35	-	-	2	-	-	-	-	-
Financial infrastructure	-	-	8	-	16	4.24	-	-	-	-	-	-	-	-
Technology infrastructure	16	3.91	-	-	-	-	-	-	-	-	-	-	-	-
Communication plan	14	3.62	4	-	5	4.11	9	-	-	-	9	0.70	-	-
Organizational structure	12	3.89	-	-	17	3.24	7	-	-	-	-	-	-	-
Project selection & prioritization	-	-	5	-	10	3.88	5	-	-	-	-	-	3	3.7
Linking LSS to supplier	6	3.10	-	-	18	3.19	-	-	-	-	-	-	-	-
Linking LSS to customers	5	3.76	-	-	6	4.07	3	-	-	-	7	0.66	-	-
LSS awareness	-	-	-	-	7	4.03	-	-	-	-	-	-	-	-
Data availability/trustworthiness	-	-	-	-	9	3.88	-	-	-	-	-	-	-	-
Linking LSS to business strategy	-	-	-	-	3	4.26	2	-	-	-	-	-	-	-
LSS resources	-	-	-	-	12	3.77	10	-	-	-	-	-	-	-
Leadership style	-	-	-	-	4	4.14	-	-	-	-	-	-	-	-
LSS tools and techniques	17	3.76	-	-	14	3.65	4	-	-	-	5	0.61	-	-
											6	0.60		
											8	0.65		
Rewards & recognition system	-	-	2	-	19	3.04	11	-	-	-	-	-	-	-

Author/Year	Hilton et al. (2008)	Jeyaraman and Teo (2010)	Laureani and Antony (2012)	Manville et al. (2012)	Zhang et al. (2016)	Ahmed et al. (2018)	Mishra (2018)
Competency of master black belt and black belt Establish LSS dashboard	-	-	10	-	-	-	-
Benchmarking	3	3.37	-	-	-	-	-
Project management skills	15	4.20	-	-	15	3.54	12
Best practice	-	-	7	-	-	-	-
Project tracking & review	-	-	-	-	11	3.80	-
LSS goal clarity	-	-	-	-	-	-	8
Facilitation	9	3.54	-	-	-	-	-
Process improvement	10	3.57	-	-	-	-	-
Design & Engineering	18	3.64	-	-	-	-	-
Production	19	3.45	-	-	-	-	-
Organization readiness	-	-	-	-	-	-	-
Open organization	7	3.47	-	-	-	-	-
Workforce management	8	3.79	-	-	-	-	-
Selection of LSS staff	-	-	-	-	8	3.93	-
Measurement	11	3.98	-	-	-	-	-
LSS knowledge	2	4.02	-	-	-	-	-
Zero defects mentality	13	3.82	-	-	-	-	-
Quality performance	-	-	-	-	-	-	-

As mentioned earlier, “management commitment and involvement” rated seven times on the first rank, which makes it occupy the first important CSF. “Organizational culture” rated twice for the second rank, and once in the third rank, while “linking LSS to business strategy” ranked once in the second place with importance factor 4.35 and once as a third place. These ranks stated the two factors to be the second and third important CSFs respectively.

Table 5.4 The most importance ten CSFs and ranks

CSFs for lean six sigma implementation	Rank
Management commitment & involvement	1
Organizational culture	2
Linking LSS to business strategy	3
Linking LSS to customers	4
Project selection & prioritization	5
Communication plan	6
Training program & education	7
Organizational structure	8
LSS tools & techniques	9
Project management skills	10

After discussing the ranking and importance factors of these studies, it can be concluded that the important ten CSFs of LSS implementation in healthcare include: management commitment and involvement, organizational culture, linking LSS to business strategy, linking LSS to customers, project selection and prioritization, communication plan, training program and education, organizational structure, LSS tools and techniques, and project management skills as shown in Table 5.4. A conceptual framework based on these ten CSFs will be presented and discussed in the next section.

5.7 CSFs for Lean Six Sigma Implementation in Emergency Department

Critical Success Factors (CSFs) is defined as “the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization” (Amberg, 2005). This definition was given by Rockart in 1979 who was one of the researchers who found interest in studying and modifying this particular method of managing an organization. In 1961 CSF concept was first put into an idea when Daniel, a researcher, discussed “success factors” in management literature. This was then followed by Anthony and other researchers in 1972 when they further emphasized the need to modify CSF based on a particular strategic objective of an organization and on its specific group of managers. It was in 1979 that Rockart conducted a study that combined the work of Daniel (1961) and Anthony et al. (1972) wherein he defined a particular study on three organizations that confirmed how organizations in the same industry show different CSFs (Amberg, 2005).

The objective of this paper was to identify critical successful factors for Lean Six Sigma implementation in emergency departments. A Content Analysis for the most recent literature was conducted to explore the critical successful factors for Lean Six Sigma implementation. This review provides the most recent developments with respects to the CSFs to Lean Six Sigma in healthcare organizations. Each of the important ten CSFs of successful LSS implementation will be discussed in the following sub-sections:

Management Commitment & involvement. “Management commitment” has been considered to be one of the most significant critical success factors also connected Lean Six Sigma to leadership styles and business strategy (Chandran, 2014). Abou-Zeid (2010) highlighted that

without this particular factor the attempted developments will always produce a large amount of resistance within the organization and will result in negative situations. In another study, “commitment and responsibility of public and private sectors” has been recognized as one of the CSFs that play a vital role in handling partnerships between public and private organizations (Ismail & Ajija). Management commitment has been considered as the most well-known feature mentioned in different literature reviews regardless of the location and industry (Pakrudin et al., 2017). This is because long-term commitment from top management is considered to be crucial for the success of the organization’s projects (Hung et al., 2014).

Organizational culture. “Organizational culture” has been recognized as a critical success factor along with “knowledge sharing”. In their study Al-Alawi, Al-Marzooqi and Mohammed (2007), emphasized how organizations use various information systems to facilitate knowledge sharing through acquiring or making knowledge sources where employees share their skills electronically and where the shared experience becomes possible for other employees to take advantage of. In another study, “organizational culture” was recognized as a critical success factor for the success of sustainability initiatives. However, there has only been little empirical study that has been done to define the relationship between sustainability and “organizational culture” (Abbett et al., 2010). In a study related to the healthcare industry, Stock et al. (2007) aimed to examine how “organizational culture” and critical success factors may lead to the decrease of medical errors specifically in the USA hospitals. According to their findings of a survey, over 500 hospitals proposed that some characteristics of “organizational culture” are more possible to be linked with decrease in error than other characteristics (Stock et al., 2007).

Linking LSS to business strategy. Lean Six Sigma (LSS) has already been linked to the potential success of every organization if it has been implemented properly including healthcare organizations. Every organization has its own business strategy and some have already begun to consider LSS as an effective tool. For instance, Shirey (2017) was able to present a case study to improve a healthcare organization's way of providing its service when it implemented LSS through the DMAIC framework. There are a lot of specific ways to implement LSS and if it were not carefully studied before implementation, it might not yield the expected success. Therefore, it is important that every organization know how to use LSS as a business strategy for them to succeed by using the interpretive structural modeling approach (Jadhay et al., 2014; Strong, 2018). Being able to identify and understand the main features, challenges, and shortcomings of the LSS program can enable an organization to better support its strategic directions especially when its aim is to improve business processes (Kwak & Anbari, 2008).

Linking LSS to customers. LSS is highly linked to customers as to how it is perceived as a system that is used for achieving, maximizing, and sustaining business success, which is driven by a clear understanding of the needs of the customers (Pirker-Krassnig et al, 2011). In fact, customer and leadership have been two of the identified factors that play an important role in effectively implementing LSS (Habidin & Yusof, 2013). When LSS has been successfully implemented, it can improve business, and therefore, also heighten the expectation of the customers for that organization's product and/or service (Wasage, 2016).

Project Selection & prioritization. One of the critical success factors for project selection highlighted in an article was to “develop clearly defined plans with assigned responsibilities and accountabilities” (Hughes, 2010). For this factor, there is a need to define the deliverables along

with the essential tasks to generate them and any linked risks, therefore resulting the best project selection for an organization (Hughes, 2010). In another study, “iron triangle” is viewed to be a criterion for measuring the effectiveness of a project for seeing cost, schedule, and quality in conventional construction processes instead of recognizing sustainable establishments (Alias et al., 2014). Costantino, Di Gravio, and Nonino’s (2015) study was able to highlight an artificial neural network (ANN) as a critical success factor for technology infrastructure and one that categorizes the level of the project’s hazardousness by removing the experience of project managers from a group of previous effective and non-effective projects.

Communication plan. Communication is one of the leading critical success factors recognized by several researchers (Ika et al., 2012). Ika et al. (2012) highlighted how communication and trust formed between the leaders of the World Bank project and the coordinators of national project influenced the success of their project. In another study, ineffective communication has been highlighted as a significant causal factor in inadvertent patient harm and medical errors. Therefore, there is a need to provide effective ways of how communication can be improved (State of Victoria, 2010). Part of the critical success factors for communication in the healthcare sector highlights the five standards of effective communication, which can facilitate improvement in the exchanging of information between healthcare professionals. These five standards include “complete; concise; concrete; clear; and accurate” (State of Victoria, 2010).

Training program & education. Providing high-quality service of an organization, effective training is highly essential. For instance, Bhatti (2005) was able to recognize how several projects fail in the implementing enterprise resource planning (ERP) because of the lack of proper training. Several researchers, and even professionals, agree to the fact that effective training is a

vital factor for a successful implementation of a particular method in an organization's project. In another study, ineffective communication amongst medical teams has been viewed to be a top cause of preventable patient harm. Effective training was one of the issues that has been missing or lacking (Salas et al., 2009). In the research by Irfan et al. (2014) they found that there is an increasing cost of healthcare and high expectations of customers for quality service, and therefore, effective training is viewed to be essential in providing the current demand especially in the healthcare and emergency departments.

Organizational structure. Gates (2010) was able to present a critical success factor for “organizational structure” through the Parsons/Thompson model of organizational structure. It is a model that is utilized to organize enterprise architecture concepts. The model recognizes three general levels that were common to most organizations. This CSF reveals how the teams are flexible and can change an organization's goals, make-up, or function as required by external or internal influences (Gates, 2010). In another study, exceptional performance in an organization was only observed where sufficient organizational structures were found to be in place and where particular capabilities of IT service deliveries were refined and these became possible through critical success factors for the IT industry.

LSS tools & techniques. The Lean Six Sigma tools that largely contribute to enterprise success include brainstorming, mistake proofing, standardization, and process mapping (Anbari, 2002). The devices are preferred by organizations since they help in streamlining, optimizing, and improving every aspect of the organization. The concepts of Lean Six Sigma are mainly popular among large companies since its tool and methodology influence output, quality, and finances enabling the company to strengthen itself in the market, and thus, obtaining competitive advantage

(Bakar, Subari, & Daril, 2015). However, the realization of the best results is not easy, and furthermore, without project purpose, adequate training of employees, statistics, success may not be realized. According to Hayes (2018), alignment is a crucial determiner of success attainment also.

Project management skills. Lean Six Sigma project management skills connect to the identification, project design and control tools, development approaches, and methods for evaluation of post-project (Peterka, 2009). Although there are benefits realized through integrating project management methodologies and Lean Six Sigma, there can be some misconceptions that might affect the organization negatively. For that reason, there is a need to ensure alignment of project scope, timeline budget, and complexity (Congemi, 2018). The project manager has the role of determining the processes and tools that increases the success probability of the company. Teams without the project management and Lean Six Sigma experience more frustration from a lack of set objectives. Lean sigma enhances the measurement of performance in alignment with customers' needs using various statistical and variation tools (Congemi, 2018).

5.8 Summary of Existing Literature on Conceptual Frameworks of Lean Six Sigma

In the study by Amar and Davis (2008), the researchers studied the four implementation frameworks that they gathered from literature from two perspectives. The first was a critical success factor perspective and the other one highlighted the perspective of the diffusion of innovation theory developed by Rogers (Amar & Davis, 2008). Neither of these frameworks was able to address the issues that were suggested by the diffusion of innovation theory. Amar and Davis (2008) studied Lean Six Sigma's use within these frameworks focusing on the effects on the

small- and medium-sized enterprises (SMEs) in India. After analyzing the findings and drawing from the literature that highlighted critical success factors, the researchers suggested that a customized implementation framework is necessary in order to design Indonesian SMEs based on the diffusion of innovation approach of Rogers (Amar & Davis, 2008).

In another study, Chakrabarty (2009) discussed the issues of implementing Lean Six Sigma in every organization. One of the areas that the researcher focused on is the development of a conceptual framework for implementing Six Sigma in service organizations with the use of grounded theory methodology. In the same study, the researcher has also focused on critical success factors, but they also added other factors, such as “critical-to-quality (CTQ) characteristics, key performance indicators (KPIs), and set of tools and techniques (STTs)” (Chakrabarty, 2009).

The Furterer (2004) study focused on providing a framework roadmap for implementing Lean Six Sigma in local government agencies because it has been weakly represented in the literature review. The study highlighted the use of the Service Improvement for Transaction-based Entities Lean Six Sigma Framework Roadmap (SITE MAP) and how it determines the activities, tools, principles, and significant component factors in implementing Lean Six Sigma. Furterer (2004) emphasized how this framework offers a synergistic approach in integrating the tools and concepts of Lean Enterprise and Six Sigma with the use of Define-Measure-Analyze-Improve-Control (DMAIC) problem solving approach. A case study was used in validating the framework and provided a discussion about Lean Six Sigma being successfully applied in a municipality to decrease the cycle time for the financial processes particularly in the city government’s finance department (Furterer, 2018).

The purpose of Lean Six Sigma is to improve the quality of care services, lessen the variation, and remove the waste in an organization (Zhang et al. 2016). This program has been based on the concepts of joining two improvement programs known as Lean manufacturing and Six Sigma. These programs have been highly praised but only few articles were able to address its capability to improve an organization's process. That being said, this literature review has aimed to provide a more comprehensive, relevant, and credible discussion on how Lean Six Sigma along with the different conceptual frameworks applied or joined with this program is capable of providing advantages to organizations. However, the existing literature review emphasized the lack of literature that discusses the conceptual framework of LSS in emergency departments. Therefore, this paper provides the conceptual framework of successful implementation of LSS in emergency departments based on the ten most important CSFs.

5.8.1 A conceptual framework of successful implementation of lean six sigma in emergency departments

The developed framework represents the ten most CSFs that contribute to the successful implementation of LSS in emergency departments. This framework also provides the LSS tools, based on the conceptual understanding, that help to execute each factor of the CSFs, as well as the expected outcomes commonly associated with the implementation of LSS. This framework developed an effective framework for healthcare providers and organizational consultants. Based on the literature review, the conceptual framework has been developed and shown in figure 5.2.

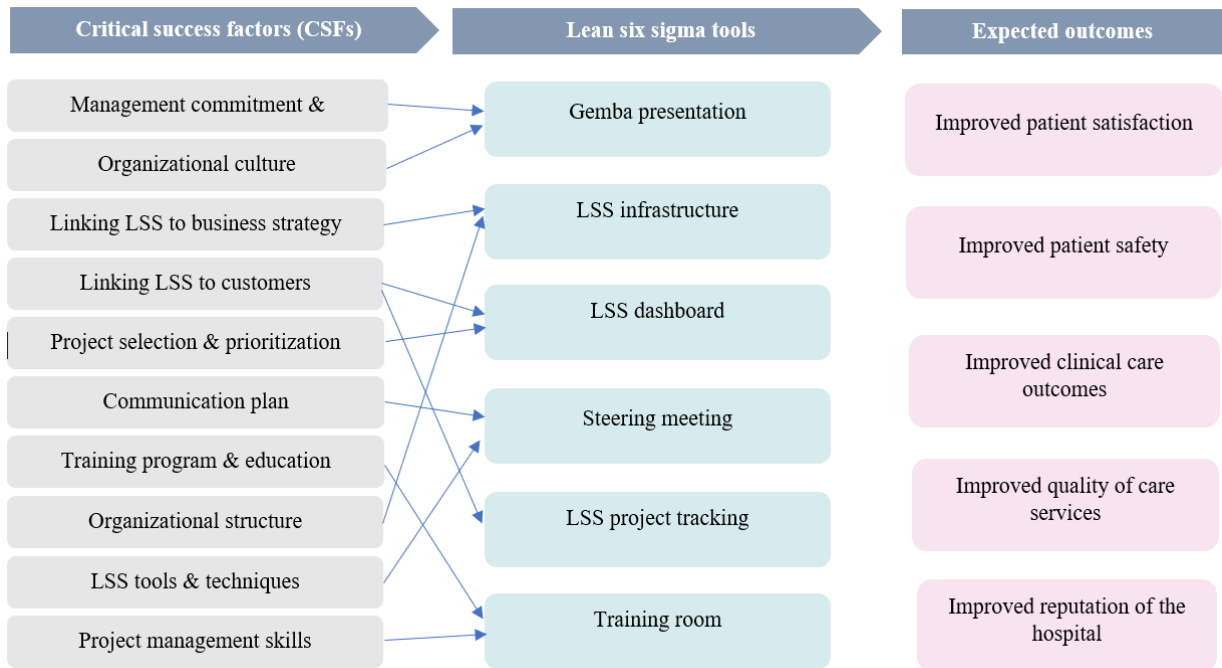


Figure 5.2 A conceptual framework of CSFs of LSS implementation in EDs.

Gemba presentation. Gemba has a Japanese origin. In Japanese, Gemba means the real place. In organizations and businesses practicing lean processes, Gemba means the place where the activities for creating value for the customer/client occur. Gemba walk is a lean six sigma tool that requires a management staff taking a walk to the center of activities to get a feel of different activities and understand the actual process of value creation (Firman et al., 2019). In applying this tool, the management seeks to understand processes and asks questions (Arafeh et al., 2018). The focus of a Gemba walk could be a particular process or activity. The Gemba walk serves as a link between the management and the staff directly involved in the creation of value in the form of products and services. The overall goal of a Gemba walk is to understand the flow of activities from inception and the starting point, identification of issues and the proffer of solutions to the issues identified. For the emergency department, the Gemba walk would

involve a management or designees visiting the floor of the department and observing processes that range from triaging patients to referring them to the appropriate specialist (Moldovana, 2018).

LSS infrastructure. To implement Sigma Six effectively, a team must be in place. The LSS infrastructure includes a team of professionals at different levels with the skills and experience required for the implementation of LSS processes. The different categories of professionals that make up an LSS infrastructure include executive, project sponsors, champion, master black belt, green belt, black belt, and yellow belt. The executives are the most senior professionals. They are responsible for developing the goals of the organization and appointing professionals in the other categories (Vashi et al., 2019). The champions are responsible for the bridge between the project sponsors, otherwise known as project owners, and the executives. Project sponsors are directly in charge of different projects. Professionals within the master black belt to yellow belt categories possess different degrees of Six Sigma skills, such as coaching, training and project management. This infrastructure can be effectively created in an emergency department; for example, with a green belt executive managing hundreds of staff (Sánchez et al., 2018).

Lean Sigma Six dashboard. A dashboard is a tool that provides an overview of critical activities and metrics; otherwise known as key performance indicators (Firman et al., 2019). Six Sigma dashboards are designed to provide real-time information about the factors and activities most important for achieving a particular goal. At a glance, one can get an overview of current performance against objectives from a dashboard. The important information for measuring productivity against objectives is displayed in comprehensive manners in a dashboard (Improta et al., 2018). Lean Six Sigma dashboards include digital dashboards available in different forms. LSS is important for the real-time monitoring of growth and productivity metrics. An LSS dashboard is critical tool for understanding patient flow within the ED. A dashboard is a tool that allows all status and information to be displayed in one location (Mousavi et al., 2019).

Steering meeting. To effectively implement Six Sigma, a group of high-level executives that provide strategic guidance is necessary to guarantee success of the process implementation and continuous improvement of the project. This group of professionals make up the steering committee. As the name suggests, it is the duty of this committee to steer activities in the right direction for growth and productivity (Furterer, 2018). Steering meetings are where the committee discusses the strategies for implementing Six Sigma. These meetings are usually periodic with goals set and reports of previous activities and meetings are made (Arafah et al., 2018). During these meetings, data from members who represent the different organization units are gathered and implemented. Steering committees are important for the optimization of activities in emergency departments. The committees could include medical and non-medical staff (Sánchez et al., 2018).

Lean Six Sigma project tracking. Lean Six Sigma project tracking is an effective tool for monitoring the progress of projects and monitoring them to achieve the required objectives (Improta et al., 2018). Lean Six Sigma project tracking differs from regular project tracking and management in that it allows data-driven management of projects against specific goals. Executives and managers get to comprehensively monitor growth and identify processes that can be improved. Lean Six Sigma project tracking does not supplement existing measures. It replaces traditional project management measures by making specific observations and analyses and proffering appropriate solutions (Vashi et al., 2019). The application of Lean Six Sigma project tracking in emergency departments will enable the identification of key areas for providing optimal care and managing cases within the shortest period possible (Furterer, 2018).

Training room. The training of staff at the different career levels is important for achieving the goals of the organization. The effectiveness of trainings is dependent on factors that include the trainer, the training content, and the environment (Sánchez et al., 2018). Training rooms are environments specifically designed for

delivering effective training. The training room should be designed with specific features and tools for effective communication. The design of these rooms encourages maximum interactions between the trainees and the trainer (Al-Qatawneh et al., 2019). Technological aspects of a training room are especially important. Training room technology should include high-tech audio and visual technology. Since training rooms are part of a bigger establishment, they should be designed to ensure that activities within the room do not interfere with those outside the room. Noise level should be especially considered. In healthcare settings, patient flow and accessibility should also be considered in designing training rooms (Terra & Berssaneti, 2018).

5.9 Conclusion and Future Work

Emergency departments face several problems; such as patient safety, overcrowding, delays, and cost-related issues. LSS is the best tool, based on the studies analyzed, to address common problems in the Emergency Departments. For this reason, this study aims to investigate the CSFs of successful Lean Six Sigma implementation in healthcare. A Content Analysis was used to conduct a comprehensive review of studies that analyzed the role and impact of different critical success factors, especially those that were used in healthcare. This study focused on identifying, critically assessing, and integrating the findings of relevant studies that addressed one or more of the research questions. This study focused on the topic of critical success factors, Lean Six Sigma, and how these methods can play a significant role in healthcare, and how critical success factors have played roles in different healthcare organizations. Furthermore, this study conducted a comparative analysis of the ranks and important factors of individual CSFs of the selected articles from the literature review. For the comparative analysis within the healthcare sector, seven articles from different countries were considered. In total, 36 CSFs of Lean Six Sigma

implementation were identified throughout all these articles. There were ten critical success factors that were analyzed in this study.

In addition, a conceptual framework for CSFs of Lean Six Sigma implementation in healthcare was developed based on these factors. Based on these seven articles, the results showed that the CSF, “management commitment and involvement” is the most important factor for Lean Six Sigma implementation in healthcare. It is followed by the CSFs: organizational culture, linking LSS to business strategy, linking Lean Six Sigma to customers, project selection & prioritization, communication plan, training program & education, organizational structure, and Lean Six Sigma tools & techniques. In addition, the CSF, “project management skills” was considered as the last relevant factor in the list. These CSFs have been adopted in the healthcare industry and considered as critical factors in providing a higher quality of service and safer service for their patients. With the use of these findings and the establishment of a theoretical framework within the healthcare systems and specifically the emergency department, the department should see less overcrowding, enhanced patient safety and more cost cutting to improve overall quality within the department.

This study provides multiple opportunities for further empirical research. The provided conceptual framework is a theoretical model and needed to be empirically tested by conducting an expert study which concentrates on analyzing expertise from chosen experts regarding significant topics identified within the target domain of study. Moreover, the framework could be empirically tested by implementing a real case study in the ED. In addition, this study leaves the field open to further research to conduct comparable studies and develop different lean six sigma conceptual frameworks for different departments in healthcare organizations.

5.10 References

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CHAPTER 6: EXPERT STUDY ROUND 1

Lean Six Sigma Implementation in Emergency Department: A Qualitative Case Study Using Grounded Theory

Note: This chapter is the first manuscript of this dissertation and an appropriately formatted version is planned to be submitted to *Journal of Industrial Engineering & Management* (IF=2.11) on July 31, 2020.

6.1 Abstract

Purpose - The objective of this study is to develop a theoretical model of the factors that affect Lean Six Sigma (LSS) implementation in emergency departments (ED), as well as explore the elements of work environment that affect the implementation

Design/methodology/approach - This paper reports the results of a qualitative grounded theory study with 36 subject-area experts. Data were collected through survey questionnaire and analyzed to identify the categories and sub-categories that emerged from the survey data and the relationships between them.

Findings - The findings illustrate aspects that impact the implementation of LSS in the ED including preparation, execution, support, work environment, outcomes, barriers, and measurements. The findings also suggest that LSS implementation leads to the improvement of the ED's processes. Therefore, the study contributes to the existing body of knowledge in successful implementation of LSS in EDs.

Originality/value - This study has developed a theoretical model of successful implementation of LSS in the ED which could be applied to help EDs use LSS so that they can achieve outcomes and overall performance bringing better emergency care to society. The developed framework can be considered as an extension of existing knowledge of LSS implementation in the ED. The contribution of this study is to identify the elements of work environment to be added to the existing theoretical model of factors that affect LSS success, as well as to verify the existing theoretical model by also synthesizing the list of the factors of LSS implementation.

Keywords Lean Six Sigma, emergency department, grounded theory, theoretical model

6.2 Introduction

Every organization faces challenges, and this does not exclude hospitals or healthcare facilities. Like any organizations, hospitals also face challenges and especially in the emergency department (ED) where urgent patient care is highly needed. For some healthcare facilities it is very difficult for their teams to discover the hindrances that keep their facilities from providing high quality patient care. Through the knowledge of LSS, this study aimed to determine how LSS can be properly implemented through the use of GT model (Strauss & Corbin,1990).

LSS is defined as “a fact based, data-driven philosophy of improvement that values defect prevention over defect detention” (Rastogi, 2018). This new method combines the methods, principles, and tools of both lean and six sigma methods into one powerful approach for improving the operations of an organization. The LSS approach has been viewed as a team-oriented approach and got its roots in the United States in the 1980s as an assimilation of management principles and processes that were initiated by the US in Japan for post WWII rebuilding. Then in the US in the

1980's the aim of the managers was to compete with the products from Japan that had been produced through the implementation of both the Lean and Six Sigma approach (Kenton, 2018)., LSS method was introduced by Robert Lawrence Jr. and Michael George in their book *Lean Six Sigma: Combining Six Sigma with Lean Speed* that was published in 2002 (Kenton, 2018).

This study used a qualitative study, Grounded Theory (GT), in assisting the implementation of LSS based on the collective experience of a panel of experts. GT provides in-depth understanding of the human behavior and help us to determine 'how' and 'why' organizations behave in certain ways (Creswell 2002). Such an approach offers the researchers the challenge of providing a developed theoretical model that can help not just one healthcare organization that is facing the highlighted issue, but also other healthcare organizations that are or may face this issue in the future. The results of this study used to develop a theoretical model that will serve as an essential tool in helping the healthcare facility's ED personnel to improve its management processes by integrating the LSS methodology.

6.3 Background

Both Lean and Six Sigma have been considered as management methodologies instead of group of approaches. Some of the experts have considered Lean and Six Sigma to be equally exclusive while others perceive more similarities than its differences (Maleyeff, 2007). Either way, it has been perceived to be beneficial for experts to comprehend the roots of every approach as well as their philosophical origins, thus deciding which tools and its characteristics would best suit a certain situation (Timans et al., 2012). LSS and its tools have established an impact on the operations of several companies in a sense that the tools of the two methodologies combined have

been observed being utilized in endorsing improvements in quality both as a strategic and systematic way (Breyfogle, 2015; Delgado et al., 2010).

Both Lean and Six Sigma practical tools are an essential part of any business process improvement initiative. Figure 6.1 shows a list of Lean and Six Sigma tools, including those shared by both (Aboelmaged, 2010; Ahmed et al., 2018; Cudney & Elrod, 2011; Douglas & Douglas, 2015; Holden, 2011; Jeyaraman & Teo, 2010; Lee & Chang, 2010; Timans et al., 2012; Zhang et al., 2016). This list is not exhaustive and as Martin (2007) and Spector (2006) stated, these initiatives methodologies are still evolving. The typical Lean tools include the 5s, Kanban System, Value Stream Mapping, Kaizen, Visual Management, Takt Time, Total Preventative Maintenance, Waste Walk, One Piece Flow, and Quick Changeover (Zhang, 2014). On the other hand, typical Six Sigma tools include Design of Experiment, Analysis of Variance, Regression Analysis, Statistical Process Control, Suppliers-Inputs-Process-Output-Customers analysis, Project Charter, Management System Analysis, Quality Function Deployment, Failure Mode and Effect Analysis, and Responsibility Assignment Matrix (Fursule et al., 2012; Keller, 2005). Common tools include Pareto Chart, Process Mapping, Cause and Effect Analysis, Histogram Chart, Poka-Yoka, and Fishbone Diagram (Fursule et al., 2012; Keller, 2005).

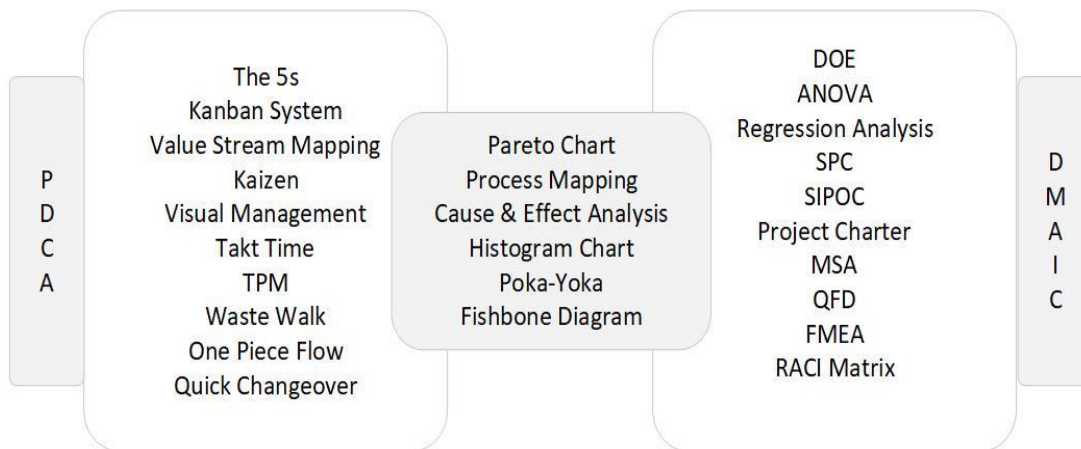


Figure 6.1 LSS tools

The LSS tools are incorporated in its Define-Measure-Analyze-Improve-Control (DMAIC) improvement project execution roadmap (Breyfogle, 2015). The implementation of the roadmap is to establish strong processes that will allow businesses to achieve high standards and that are able to help maintain operational control. The PDCA cycle is a four-step management process used for managing Lean projects. Although there have been many successful LSS implementations, there are still many challenges when applying such an approach to attain the benefits.

6.3.1 LSS implementation benefits, challenges, and critical success factors

The LSS is significantly beneficial from a healthcare perspective. The Lean principles offer a fast reduction of delivery blocks and unnecessary motion observed in a process of an organization (Abu Bakar et al., 2015). Six Sigma, on the other hand, imposes a data-centric thoroughness that

yields better products or services and higher quality. Acute care-based LSS health care process improvement programs have also been observed to produce significant financial and operational benefits (Ahmed et al., 2018; Al Owad et al., 2013). This demonstrates the focus of lean manufacturing on streamlining the flow of products and/or services and removing the waste. On the other hand, Six Sigma focuses, by applying thorough statistical control methods, on decreasing the variation in a process or whole production line (Lewis-Piere et al., 2017; Yaduvanshi & Sharma, 2017). One of the significant benefits observed in healthcare was shown when a hospital in London applied LSS and was able to reduce the length of stay (LOS) of their average patient by 25%, and thereby resulted in closing 78 beds and reducing related operation expenses while still maintaining their original service capability and levels (Yaduvanshi & Sharma, 2017).

One of the recognized challenges in implementing LSS, specifically in the healthcare operations, involves how it lacks a holistic and accurate approach as a composite model of the Lean methodology and Six Sigma (Yaduvanshi & Sharma, 2017; Zafiroopoulos, 2015). Implementing LSS has been a challenge for some because of the fundamental change in the way program managers at every level must think through all process of the business, which then leads to changes that are associated with the culture of the organization (Yeh et al., 2011; Herbert, 2008). For success, these cultural changes are not short-term but eventually become embedded in the continuous improvement process. In this case, the integration of continuous improvement, removing waste, and decreasing costs should become the new cultural approach and norm within an organization (Nakhai & Neves, 2009; Herbert, 2008). In general, it has been found that common challenges include lack of management support, resistance to change, lack of resources, lack of LSS knowledge, insufficient training, misalignment of project and organizational goals, and

budget and time restraints (Buestan et al., 2016; Jeyaraman & Teo, 2010; Kwak & Anbari, 2006; Lee & Chang, 2010; O'Rourke, 2005; Snee, 2010).

When it comes to identifying the critical success factors of implementing LSS in organizations, many studies developed conceptual frameworks or theories of critical success factors (Achanga et al., 2006; Ahmed et al., 2018; Habidin & Yusof, 2013; Hilton et al., 2008; Jeyaraman & Teo, 2010; Laureani & Antony, 2012; Manville et al., 2012; Mishra, 2018; Timans et al., 2012). For instance, Abu Bakar et al. (2015) were able to review and gather the critical success factors of LSS deployment and implementation and created a comprehensive list of the said factors. The five significant critical success factors included: (1) organizational infrastructure and project management; (2) management commitment and leadership; (3) Lean Six Sigma competencies; (4) training and education; and (5) linking LSS to business strategy.

6.3.2 State of LSS implementation in emergency departments

In today's highly developed global economic environment, medical service has always been vital. The quality of delivered service is as vital as the service itself, and customer satisfaction has always been the most important goal (Abeidi et al., 2018; Johnson et al., 2010). Since healthcare systems are organizations that also provide service to patients, they have become more attentive to the improvement tools provided for their industry (Alwan 2012; Dickson et al., 2009). To improve processes and quality performance, many emergency departments applied Lean Six Sigma with one of its goals including the reduction of patient length of stay (Bisgaard et al., 2009; Blick, 2013; Johnson et al., 2004; Wolf, 2009), improved laboratory (Blick, 2013), improved

inventory management (Tettey, et al. 2016), improved patient flow (Al Owad et al., 2013; Furterer, 2018; Stanton et al., 2014;), and reduced errors (Johnson et al., 2004).

In a particular study, Furterer (2018) applied the Lean Six Sigma DMAIC methodology where the goal was to reduce the length of stay of the patients and the number of patients leaving without treatment. After just three months the length of stay of the patients was reduced by 30% and the percent of patients leaving without treatment was reduced from 6.5% to 0.3%. The project has been a success and there were several factors observed to have contributed to its success. This includes how the leader of the healthcare was highly visible throughout the process of implementing the project and was also exceptionally engaged in the process. The team members who were assigned to implementing the Lean Six Sigma were highly knowledgeable and operated well as a valued team. When it comes to recognizing the facilitator of the LSS methodology, the facilitator was found to be highly experienced with both the change management and technical skills (Furterer, 2018).

In another study, Hagg et al. (2007) discussed a project for Saint Margaret Mercy Hospitals in Hammond, IN, that aimed at adapting LSS methodologies for use in the optimization of the lab services for an emergency department. The study was able to highlight how LSS can really play a significant role especially in improving the medical lab tests' role in healthcare facilities. The response time for these tests is considered to be very critical in providing quality care for patients especially in the emergency department. The findings showed a successful implementation of the LSS methodology, which focused on improving the phlebotomist and clerking processes. In view of the data, the conclusion resulted in increasing the capacity of its processes and improving the

awareness and hands-off of the processing status of the stat specimen in the emergency department (Hagg et al., 2007).

6.4 Research Methodology: Grounded Theory

The focus of this study – implementing Lean Six Sigma in emergency departments – called for an exploratory approach. A suitable approach for this study was to use grounded theory because this theory is to some degree a link between qualitative and quantitative research methods. While it aims to develop a theory, it fully depends on the data to disclose or reveal what the theory may be instead of just statistically challenging a prearranged hypothesis (Krueger et al., 2014). Moreover, grounded theory has also been observed to examine complicated problems in the selected case by using a process-oriented approach and thereby resulting in allowing them to develop theories (Glaser & Strauss, 1967; Krueger et al., 2014; Strauss & Corbin, 1998). After several reviews conducted regarding data, themes, incidents, and categories strategy began to emerge. Coding is the vital link between gathering or producing data and developing a theory that describes the data. The specific genre of grounded theory used in the current study is developed GT, which specifically includes open, axial, and selective coding (Glaser & Strauss, 1967).

The results showed that studies in the literature are starting to focus on this area and mainly use field techniques such as surveys and interviews, etc. to make empirical observations. Now that the research area is beginning to mature, experts and experienced industry professionals are more common. This calls for an expert study to pool their collective experience to generate a conceptual framework to guide implementation success. The comparison can be made of the model derived from the literature review (Chapter 5) and the model resulting from this study to develop a model

of LSS success in ED that represented the synthesis of current knowledge and evidence in this field.

6.4.1 Data collection

The data for this study were obtained by conducting an expert study which includes using a survey questionnaire with grounded theory to analyze qualitative data. An expert study is a data collection approach which concentrates on analyzing expertise from chosen experts regarding significant topics identified within the target domain of study. The study samples for this research consisted of industry experts or ‘professionals’ who were participated in LSS projects to improve the ED. In addition to these experts, academic experts who have published an article in a peer-reviewed journal regarding use of LSS in an ED were also included.

A survey questionnaire was used, which consisted of two parts. The first part was intended to determine the general demographic information to obtain basic information about participant background, including description of current professional position, number of years of professional experience, countries of implementation, type of organizations, and represented roles in the projects. The second part consisted of open-ended questions focused on obtaining information regarding the experts’ experience including the significance of the success factors, challenges, and outcomes, as well as identifying any other additional factors or outcomes that are significant to the LSS implementation process. Furthermore, the process was used as a vehicle to obtain information on the role and importance of the ED work environment and its relationship to the achievement of outcomes such as reduction of patient LOS. The open-ended questions allow participants to provide unstructured and unbiased information.

The survey questionnaire conducted in this study was built from the observations made during different quality improvement projects and the background understanding of the quality area. These previous experiences helped to provide a strong starting point in developing the survey questions. In order to ensure that the data collection instruments were appropriate, a draft of the survey questionnaire was pilot tested by several industry professionals and academic researchers who have a professional experience with LSS implementation in EDs or in healthcare in general. Some minor changes were made based on their feedback and comments.

The sampling approach is very important in that the creation of theory depends on accuracy in collecting data and how the target population could respond to the survey questionnaire. Additionally, a critical point in the sampling approach is to avoid information bias by accomplishing a state of systematic sampling, as well as by obtaining responses that will help develop a theory that is sound and unbiased. To supplement this sample of experts, potential participants were identified through relevant research communities and associations, such as the *American Society for Quality*, the *American Society for Engineering Management*, and the *Quality Control & Reliability Engineering of the Institute of Industrial & System Engineering*, as well as social media such as LinkedIn.

The questionnaire was conducted as a web-based survey and hosted an online survey platform in January and February 2020. An invitation email including a link to the online questionnaire and a cover page explaining the objective of the study was sent to all potential participants. Additionally, a reminder email was personalized and sent for those who had not started or not completed their survey. A total of 36 participants including both industry professionals (n=15) and academic researchers (n=21) completed the online survey questionnaire.

6.4.2 Participants

Table 6.1 describes the profile of participants based on the self-assessment made by the respondents. This information included years of experience, number of implemented projects, organization type, training and certificates, and measure of success. Starting with the year of experience, out of the 36 participants, 13 (36.1%) out of the 36 participants have quality experience ranging from 3 to 9 years and 13 (36.1%) have about 10 to 18 years of experience. All other 10 participants (27.8%) have more experience ranging from 20 to 30 years, with an average of 21 years of experience suggesting that they have sufficient collective experience to provide valid empirical data for the study. All participants in this study had the skills and experience required for implementing various quality initiatives projects, such as LSS, and most participant had a moderate-to high amount of experience with Lean Six Sigma implementation. . About 27.8% of the participants indicated that they had implemented 1 to 4 LSS projects in ED, while the rest indicated 5 to 10 projects (33.3%), 11 – 20 projects (22.2%), 21 – 30 projects (5.6%), more than 50 projects (8.3%), and more than 200 projects (2.8 per%). The majority of the projects focused on business management and operational issues of the ED, which improved both physician and employee satisfaction rates. Other LSS projects that the participants indicated to have become part of their experiences include the aim of reducing defects in the emergency department, allowing to reduce the waiting time for their patients. Some rare projects involved standardizing the procedures for embryo transfer for a women and infant-centered hospital, reducing the surgery cycle time that increased the possible annual income of the healthcare organization, and projects applied in

surgical intensive care units resulting to a great reduction in bloodstream infections. Other projects have focused on reducing waste expenses on cancer centers, urgent care, and operation rooms.

Among 36 participants, 13 (36.1%) participants implemented LSS projects in hospitals, while only 3 (8.3%) in EDs. On the other hand, 15 (41.7%) participants executed LSS projects in both hospitals and EDs, only 1 participant (2.8%) in urgent care, and 4 participants (11.1%) in other organizations such as laboratory, blood donation center, operation rooms, and cancer center. Healthcare organizations may help in delivering better patient care by understanding the needs and expectations of the patients to ensure quality. This has been recognized to be possible through the implementation of LSS projects especially in the overall operations of the hospitals where it was used to reduce the overall cost and improve the overall patient care. However, when it comes to specific needs of different areas within healthcare, implementation of such projects is still found to be scarce and therefore still seeing a lack of improvement for patient care, especially in emergency departments. Several studies were able to eventually address this issue when the overall healthcare performance has only been the goal and failed to focus on specific areas of the facilities.

Green Belts, Black Belts and Master Black Belts are LSS certifications, awarded to people who have demonstrated their mastery of the LSS methodology through the implementation of several improvement projects. In this study, 15 (41.7%) of participants were certified Green Belts, 10 (27.8%) participants were Black Belts, and 8 (22.2%) were Master Black Belts. The other three (8.3%) participants were certified with different certifications such as MBA, CQA, and TQM. The survey participants were asked to select the measure of the implementation success from multiple choices on a given list.

Seventeen (47.2%) participants considered the implementations they had participated in or directly observed as completely successful, 15 (41.7%) as somewhat successful, and 4 (11.1%) as moderately successful. Surprisingly, none of the respondents indicated the unsuccessful implementation of LSS. This suggests LSS is an effective methodology to improve the processes and quality control in spite of the challenges, leading to better services such as quality, cost, and lower defect rates. Several quality healthcare professionals who participated in the survey shed light on the importance of LSS implementation in healthcare organizations as well as its benefits and challenges (Arafeh et al., 2018; Firman et al., 2019; Furterer, 2018; Importa et al., 2018).

Table 6.1 Participants profile

	Frequency (total 36)	Percentage (%)
<i>Year of experience</i>		
3 years to 9 years	13	36.1%
10 years to 18 years	13	36.1%
20 years to 30 years	10	27.8%
<i>Number of projects</i>		
1 – 4	10	27.8%
5 – 10	12	33.3%
11 – 20	8	22.2%
21 – 30	2	5.6%
50 >	3	8.3%
200 >	1	2.8%
<i>Organization type</i>		
Hospital	13	36.1%
Emergency Department	3	8.3%
Both	15	41.7%
Urgent care	1	2.8%
Other	4	11.1%
<i>Training & Certificate</i>		

Green Belt	15	41.7%
Black Belt	10	27.8%
Master Black Belt	8	22.2%
Other	3	8.3%
<i>Measure of success</i>		
Completely successful	17	47.2%
Somewhat successful	15	41.7%
Moderately successful	4	11.1%
Somewhat unsuccessful	0	0%
Completely unsuccessful	0	0%

The sample collected for this study displays a wide array of experiences regarding how Lean Six Sigma has been applied in the healthcare industry. For instance, the majority of the participants have been found to be experienced and skilled in using the method for several years already. Due to this, the data collected during this study represents relevant and credible evidence on how LSS is applied in ED. This sample can be expected to provide good data for the grounded theory analysis. Further, the different characteristics, such as qualifications, allowed for the investigation of associations with measured success, years of experience, number of projects, and organization type. One potential weakness of the sample is that the level of qualifications most likely affects the level of success experienced when implementing LSS in ED.

6.5 Analysis

Considering the process-based nature of the phenomenon of study, the collected data were analyzed with a systematic data coding process. GT involves three categories of coding: open

coding, axial coding, and selective coding (Creswell, 2007). The three categories of coding are stepped approaches that end with a set of theoretical propositions (Creswell, 2007).

6.5.1 Open coding

Open coding is “the process through which concepts are identified and their properties and dimensions are discovered in data” (Strauss & Corbin, 1998). Open coding involves a process used in developing the categories of the information gathered. This is the first step in the codification process, which can also be recognized as the initial coding wherein it begins the process of breaking down the data in order to parallel incident to incident and to find differences and similarities in initial patterns found in the data. The codes were inductively developed as many codes as possible in order to fully assess the best possible code that can help in proceeding the next codification process. This involves identifying, extracting, and labelling significant words or group of words. more specifically, the data were conceptualized from questionnaire responses line-by-line, segment-by-segment and including creating categories and sub-categories (properties).

The process of open coding should be systematic, as illustrated by Lincoln and Guba (1985). First, the main concepts should be identified throughout. The extracted statements with initial codes were recorded on cards and arranged into groups based on their affinities. Next, category names were chosen for the seven main themes: preparing, execution, support, work environment, benefits, problems, and measurements as shown in Table 6.2. The data was captured on Excel spreadsheets in order to add to the expert study database as promoted by Stake (1995).

Table 6.2 Categories and sub-categories of open coding

Categories	Sub-categories (properties)	
Preparing	Project selection Training LSS knowledge	Culture Timeline Organizational structure
Execution	Teams Communication Leadership style	Change strategy LSS tools & techniques Technology infrastructure
Support	Champion Executives/leaders Sponsors Management	Stakeholders Black Belts/Master Black Belts
Work environment	Staff motivation Staff satisfaction Qualified teamwork	Training program Staff engagement Change acceptance
Outcomes	Reduced patient LOS Improved patient flow Reduced errors	Improved patient satisfaction Improved processes Reduced waste
Barriers	Management (lack of commitment) Time constraint Data availability	Resistance (cultural change) Lack of LSS knowledge Buy in
Measurements	Comparison Statistical analysis Metrics	Feedback Level of satisfaction Sustainability

Through this process, this study effectively examined the data comparatively, systematically specifying the states and implying possible relationships with others. In this study, the process of open coding helped in examining how the execution and results of the LSS projects

are associated to the different categories identified on the table above. These categories helped in determining the level of efficiency of the approach and which categories are highly beneficial or not when it comes to using the LSS method in healthcare organizations, particularly on emergency departments.

6.5.2 Axial coding

The second step of the codification process is the axial coding, which is an iterative procedure for interlocking the categories gathered in the open coding during the initial phase. This can also be understood as a process to create conceptual families or groups from the summaries gathered from open coding (Strauss & Corbin, 1998). In this step, one open coding category was selected as the “core phenomenon” and the relationships with the other categories were explored. The other categories include: strategies, contextual conditions, intervening condition, consequences, challenges, and accentuation (Krueger, et al., 2014). The following Table 6.3 presents a brief definition of each category:

Table 6.3 Definition of each category

Category	Definition
<i>Strategies</i>	A plan of action designed in response to the core phenomenon of LSS.
<i>Contextual condition</i>	Situational factors that influence the LSS strategies.
<i>Social condition</i>	Social factors that influence the LSS strategies.

<i>Consequences</i>	Outcomes or benefits from using the LSS strategies.
<i>Challenges</i>	Obstacles from using the LSS strategies.
<i>Accentuation</i>	The action of emphasizing the LSS results.

In addition, this phase includes developing a coding diagram which represents the interrelationship of all categories; these relationships to the other categories are logical as shown in Figure 6.2. Based on these principles promoted by Strauss and Corbin (1998), “preparing” were chosen to be the core phenomenon-category. The related sub-categories include project selection, LSS knowledge, project alignment, timeline, training, and culture, which were the most mentioned by respondents. At this particular phase, a core category began to become evident as developed categories had been formed around a main concept. From this analysis the theoretical model was developed regarding the influence variables in LSS implementation in EDs and presented in the following.

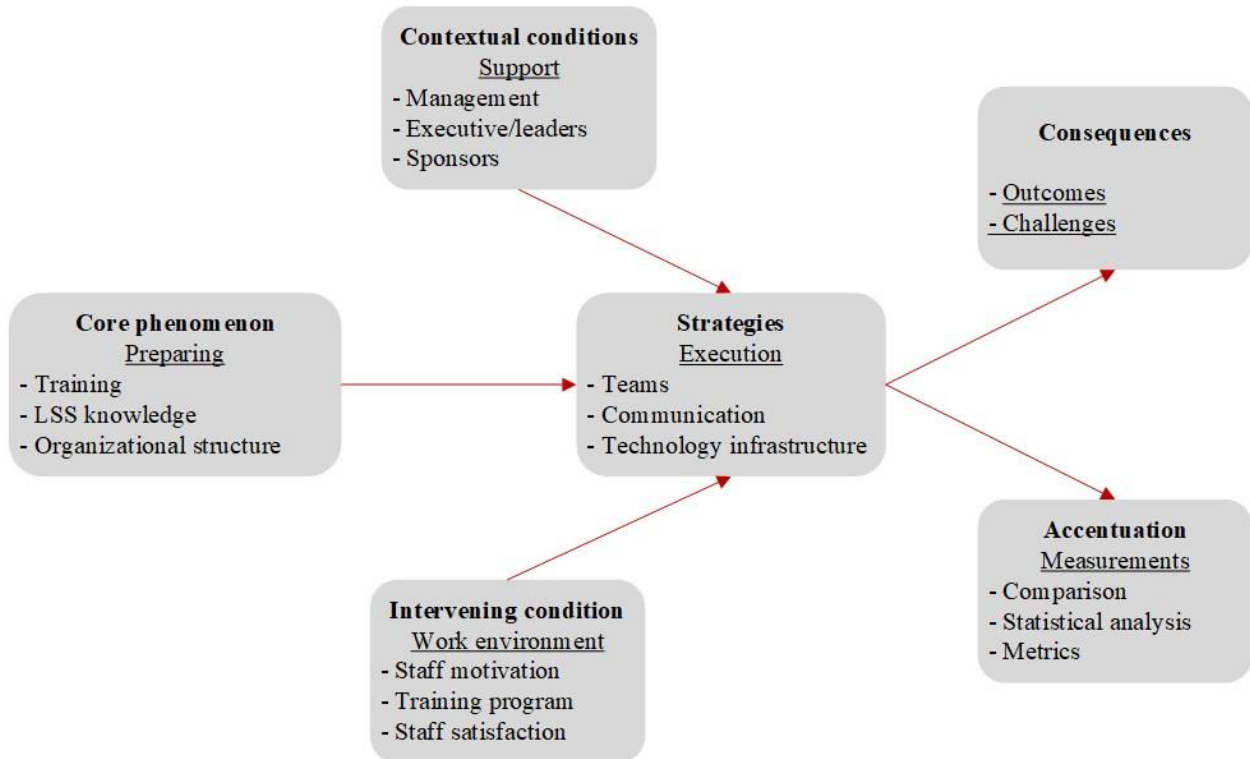


Figure 6.2 Axial coding paradigm for LSS implementation in EDs

The figure above shows the categories identified from the open coding process, which were related to other data in order to provide codes, categories and sub-categories within the voices of the participants and the gathered data. The open codes' relationship with each other has been given another term for every connection or relationship that it carries with one another. The second phase of the constant comparative analysis is essential for effectively analyzing the qualitative data

that was gathered and therefore reach the goal of developing a theory. This would not be possible if the third and last process of coding would not be done, which is selective coding.

6.5.3 Selective coding

The final step in grounded theory coding is selective coding. Selective coding is “to cease open coding and to delimit coding to only the variables that relate to the core variable” (Glaser, 1992). In this step, a theory was developed from the axial coding model, which is the interrelationships among the categories, as well as described the proposed theory (Krueger et al., 2014). This phase of coding plays a vital role in using the grounded theory approach because it is the key in producing a theory that is grounded in the collective experience of carefully selected subject-area experts. The final model of the grounded theory diagram is developed based on the response of the participants. As a result of the compilation of data, the final model is created for the procedures of implementation of the LSS methodology in an emergency department.

6.6 The Model of Lean Six Sigma Implementation in Emergency Departments

From the previous coding analysis, seven categories and 42 sub-categories were identified and organized according to their connections with each other. Seven main categories that are considered to impact the LSS implementation in emergency department have been developed: preparation, execution, support, work environment, outcomes, barriers, and measurements. Each variable is inter-related with other six sub-categories (Figure 6.3).

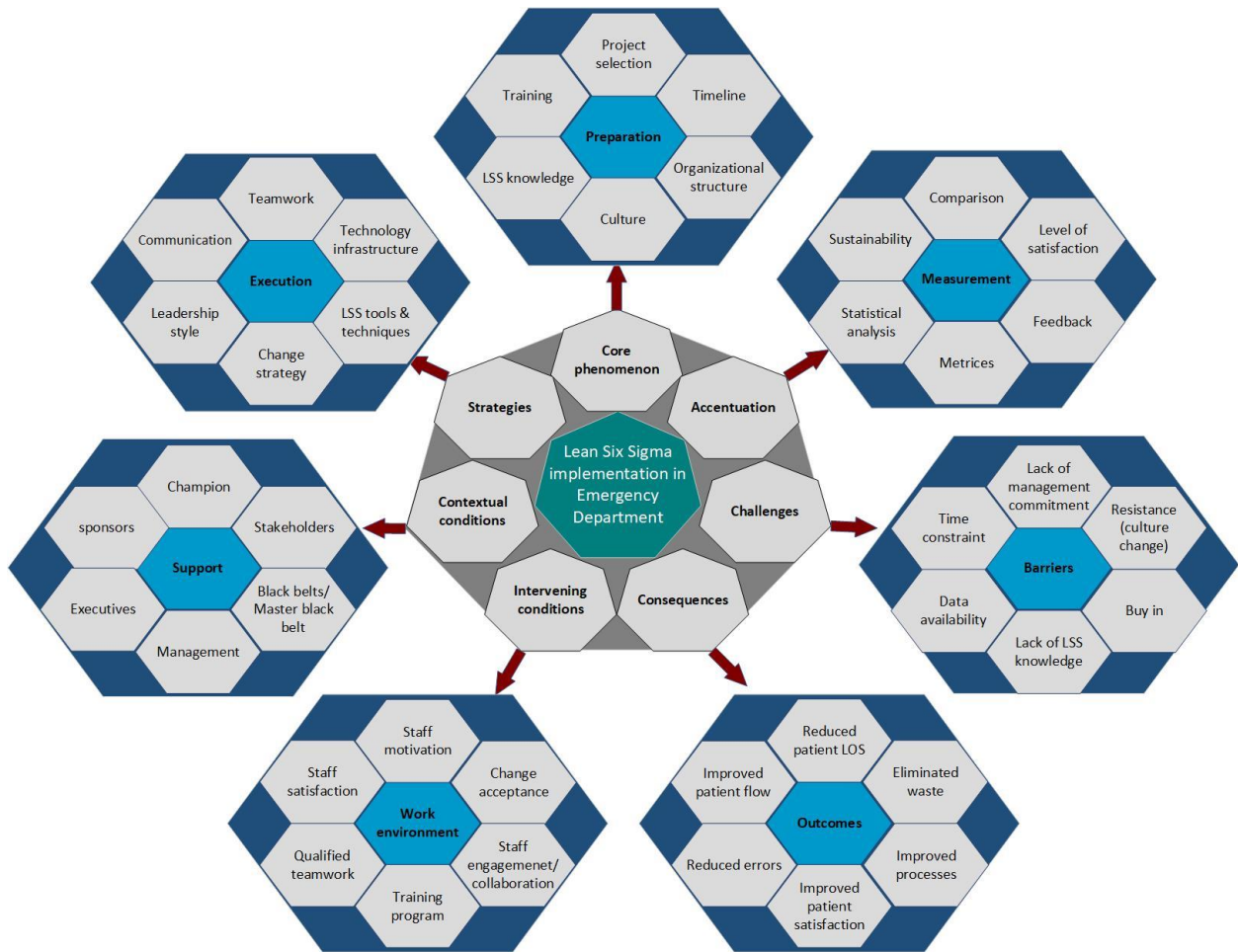


Figure 6.3 Final model of grounded theory for LSS implementation in EDs.

LSS in emergency departments is the main research theme and is featured in the center of the proposed model as an anchor point. The seven extracted categories from the axial coding phase (i.e., core phenomenon, strategies, contextual conditions, intervening condition, consequences, challenges, and accentuation) were then inserted around the main theme. For each category, specific ‘honeycombs’ are formed with the categories from the open coding phase are inserted in

the middle. Each open code category is surrounded by its sub-categories. In the following section, the main categories and their sub-categories are each discussed.

6.6.1 Validity

Merriam (1988) states “validity must be assessed in terms of interpreting the investigator’s experience, rather than in terms of the reality itself (which can never be grasped)”. In order to ensure the internal validity of this study, grounded theory includes open coding in the identification of categories and sub-categories, axial coding in creating connections between categories and sub-categories, and selective coding in developing the interrelationship of the categories to build the theoretical model (Daengbuppha et al., 2009). The process of coding proceeds until it arrives at conclusion of the emergent subject. The process ends when the advantages of further analysis are minor and when the model is significantly improved. This process is repeated until the research reaches ‘saturation’, which is when further iterations do not result in any significant changes to the code definitions or structure (Daengbuppha et al., 2009). At this point, internal validity tested and theoretical saturation is achieved.

Though the data analysis was conducted using grounded theory coding, some researcher bias may factor into the results of coding work as is expected in qualitative research. To mitigate this potential risk, inter-rater agreement exercises (Mackinnon, 2000) was conducted with a second experienced coder during the coding phases to help reduce bias and develop the codes. The joint probability of agreement (Cohen, 1968) helps to measure agreement of the codes and code structure. This process is meant to improve the coding rigor and, therefore, internal validity of the

Raw data	Open coding	Axial coding	Selective coding
different goals and are hard to integrate into the project”.			
<p><i>Q. In your opinion, what are the outcomes of successfully implementing Lean Six Sigma in an Emergency Department?</i></p> <ul style="list-style-type: none"> - “Reducing ER waiting time (from Arrival to Seen by Doctor), reducing the turnaround time of Lab and Radiology investigations, and reducing the overall ER LOS”. - “Reduction of cycle times and removal of waste elements”. - “Decrease the possibility of errors”. 	Outcomes	Consequences	

This example demonstrates the accuracy and reliability of the analysis by providing a clear structure on how the different steps of coding were executed. Starting with finding the most relevant questions to reflect the core of the issue, which will lead to finding additional relevant codes to consider. The example has also been effective in highlighting the importance of the data that were collected from the participants and how it affected the overall coding and development of the theory. Further understanding on how the different codes were formed and essential in developing the theory is discussed below.

6.7.1 Core phenomenon

During the initial open coding phase, responses were gathered regarding the factors that help in the preparation for LSS project, which revealed the following top six sub-categories: (1) Project selection, (2) Training, (3) LSS knowledge, (4) Culture, (5) Project alignment, and (6) Timeline. This top six factors show similarity of its purpose and essence, and thereby, easily

recognize the sub-category to which it belongs. Conducting open coding led to the formation of the first category “Preparation”. When it comes to recognizing the implementation of LSS, there is a need for preparation of how it would be effectively integrated and would provide a successful result in the end. The advanced phases and performance of the axial and selective coding led to select the preparation as "Core Phenomenon" and its relationship to the other categories. “Preparation” was identified as the “core phenomenon”, as its sub-category were the most essential factors involved in the implementation of the LSS in EDs.

Evaluating and choosing projects that both align with an organization's objectives and maximize its performance helps to identify the project importance and how achievable the project is (Antony & Banuelas, 2002). The LSS team members also need to have adequate training, which is vital in learning the process and the skills involved (Hilton et al., 2008; Zhang et al., 2016). LSS team members need to do a particular job or activity for the implementation process to be successful (Antony et al., 2002; Bhat et al., 2019). They also have to understand the objectives, terminology, principles, approaches, and best practices of LSS before starting the implementation (Antony et al., 2002; Bhat et al., 2019). In addition, identifying the characteristics of the cultural within the organization and whether it is favorable to the implementation process is supportive of the LSS project (Bhat et al., 2019). Having all of LSS team members working towards the same goals and values and sharing the same cultural message will work to achieve the alignment of the LSS project to organizational structure and goals and support the LSS process (Soja, 2006). Finally, in addition to these and essential to the process is the building of a timeline to track the project progress (Laureani & Antony, 2012).

6.7.2 Strategies

The second category that was included in the developing theory was “Strategies”. During the initial phase wherein open coding was performed, the top six sub-categories were gathered: (1) Teamwork, (2) Communication, (3) Leadership style, (4) Change strategy, (5) LSS tools and techniques, and (6) Technology infrastructure. This category was termed “Execution”, which plays a significant role in integrating the LSS methodology and demonstrates the need to integrate the approach in EDs.

The concepts that belong to the category of “Execution” included the reason for teamwork to achieve LSS goal and for the communication needed to share information among the LSS team members (Jeyarman & Teo, 2010). Leadership style helps in providing LSS direction, motivating LSS people, and implementing LSS plans (Zhang et al., 2016; Hung et al., 2014). A change management strategy in LSS projects requires plans to gain engagement, ease acceptance of change, and reduce resistance of change (Bhat et al., 2019). Additionally, knowledge and training about LSS tools and techniques, as well as technology infrastructure are the important factors within the emergency department for the successful implementation of the LSS projects (Laureani & Antony, 2012). The execution of the majority of these concepts has been decided to be part of the category of strategies as to how it plays a role in the strategy for the ED to improve its management processes and attain the desired results of the integration process of LSS.

6.7.3 Contextual condition

As for the third category, the open coding on the initial phase was conducted and gathered data that were related or showed similarity of its essence or reasoning. This then led to gathering the top six sub-categories that include the following: (1) Champion, (2) Sponsors (3) Management Executives, (4) Black Belts, (5) Master Black Belts, and (6) Stakeholders. This category was termed “Support”, which includes the supportive of LSS team for the project through their roles and responsibilities. The term “Contextual conditions” were chosen to describe how LSS teams would devise their strategies and create a positive effect on the project process in EDs.

“Support” is critical to successful LSS implementation (Hung et al., 2014; Laureani & Antony, 2012). Champions are typically upper-level managers that control and allocate resources to promote the process of the project (Antony et al., 2017). They are responsible for the translation of the mission, vision, and values into LSS deployment strategy which supports the goals of the ED. Sponsors are the managers or senior leaders who can greatly impact the project success because they have direct authority for the processes that need improvement (Helm & Remington, 2005). They are also responsible for providing general project support and resources for Green Belts and Black Belts (Antony et al., 2017). The role of a management executive is to own, drive, and inspire the teams involved in the LSS project. Stakeholders can impact the LSS project, but they are not directly involved in the day to day project work (Krueger et al., 2014; Vijava, 2016). Black Belts and Master Black Belts are experts in full-time process improvement positions project (Antony et al., 2017; Jeyerman & Teo, 2010). They are responsible for the strategic deployment of LSS within an ED (Jeyaraman & Teo, 2010; Tetty et al., 2016; Zhang et al., 2016).

6.7.4 Intervening condition

The fourth category developed for the final model through grounded theory was “Intervening Conditions”. In conducting the open coding on the initial phase, the six sub-categories were gathered include the following: (1) Staff motivation, (2) Staff satisfaction, (3) Qualified teamwork, (4) Training program, (5) Staff engagement/collaboration, and (6) Change acceptance. These top six sub-categories again revealed related reasoning and essence, and thus resulting in its placement within the group. these sub-categories were inserted under “Work Environment”, and thereby established that the top six belong in a category that shows how the implementation of LSS would result in seeing a new or improved way of working in the said environment.

The third category reveals the “Social conditions”. The subcategories observed as the factors related to the employees, specifically their impact on the implementation process. Achieving a satisfactory social environment will lead to success implementation of the project. (Wiskow et al., 2010). More specifically, these codes suggest the work environment is advantageous for implementing a LSS project. There would be no recognized work environment within a healthcare environment that will be highly essential in providing the pledged service that they should offer to the patients. The social conditions observed will also be linked with the aim of providing consistent staff motivation in order to consistently provide staff satisfaction, thereby recognizing how almost every subcategory involves social interactions between the healthcare professionals. Lastly, if an LSS approach or any other strategy would be used by a healthcare, the professionals’ level of change acceptance is also to be considered as a social condition that can only be observed in a work environment. These subcategories were able to identify the important

points that comprises a healthcare's work environment. After all, a hospital will never become a hospital if it does not involve socialization or social conditions linked on one another. As mentioned by Johnston et al. (2016), the working environment includes factors affecting the professional context in which ED staff work. The respondents identified the most significant subcategories that can help in developing Social conditions and thereby make use of the developed theory of successful implementation of the LSS methodology. The acceptance of change is crucial to the organization because it forms the basis to the entire concept and implementation of LSS (Zhang et al., 2016). Furthermore, the respondents were in agreement with this fact also. This was then followed by how the respondents identified the effect of qualified teamwork, staff satisfaction, motivation and engagement/collaboration, and how the training program plays a significant role in the staff performance to produce successful implementation (Johnston, 2016).

6.7.5 Consequences

The fifth group developed for the final model was “Consequences”, which consisted of the top six sub-categories: (1) Improved patient length of stay (LOS), (2) Improved patient flow, (3) Reduced errors, (4) Improved patient satisfaction, (5) Improved processes, and (6) Eliminated waste. This was again extracted through open coding during the initial phase. The open coding findings in this category revealed other answers for the question of why there is a need to integrate LSS in EDs. The category for these six sub-categories was defined this as the “Outcomes” category. In evaluating the advanced phases and conducting the axial and selective coding, the more distinct and clearer category, “Consequences”, was developed, which expressed the effects or results of an occurred action or condition.

The second category is the “Consequences” are the results or the work spent to achieve the anticipated positive outcomes or results. Majority of the responses showed a connection with the sub-category of support or work environment. For instance, improved processes and patient satisfaction would be recognized as supported by long-term management commitment to the project and effective training program based on the categories of “contextual condition” and “Social condition”. There are numerous emergency departments that have implemented Lean Six Sigma projects (Antony et al., 2006; Furterer, 2018; Laureani & Antony, 2012). Generally, the objective has been to improve measures such as safety, efficiency, quality and patient customer satisfaction, and to identify and eliminate waste, improve clinical processes, and support staff in the process to improve and examine all aspects involved including the workplace environment and culture (Antony et al., 2006).

6.7.6 Challenges

The sixth group developed for the final model was “Challenges”, which consisted of the top six sub-categories: (1) Lack of management commitment, (2) Time constraints, (3) Data availability, (4) Lack of LSS knowledge, (5) Buy in, and (6) Resistance (culture change). The term of “Barriers” was developed which illustrates the challenge observed during the implementation of LSS.

The respondents confirmed that there is a lack of management commitment during the implementation of LSS within the ED and of LSS knowledge and awareness for the majority of the respondents. Time constraints have been associated with how there is a limitation for how

much LSS project managers could provide time for implementing new strategies such as the LSS methodology. LSS team must ensure the quality, accuracy, and availability of required data to conduct the LSS project while not forgetting the need for buy-in from stakeholders for the project (Jeyerman & Teo, 2010). The fact that there can be a resistance for change in the management process might reveal the idea that there is a need for an improved performance and/or alternative to the way decisions are made that involve (Zhang, et al., 2016). Considering these factors, the changes in the concepts and practices brought with Lean Six Sigma would be a challenge in itself for the teams, but well worth the effort when the emergency departments decide to provide the best services for the patients.

6.7.7 Accentuation

The last category developed for the theory through the grounded theory model was given the term “Accentuation”. During the initial phase in open coding, the following six sub-categories were defined: (1) Comparison, (2) Sustainability, (3) Statistical analysis, (4) Metrics, (5) Feedback, and (6) Level of satisfaction. In the advanced coding phase, the last category was formed “Measurement”. Measurement in this study calls for the different measurements needed by the hospital or healthcare facility in terms of assessing the situation before, during, and after the integration of the LSS methodology. After careful consideration, the term “Accentuation” was selected for the measurement category because it presents the action taken of measuring and emphasizing the results. Accentuation provides a focused way of understanding the positive and negative results of the integration of the LSS methodology in ED.

Measuring in this process involves actions that are needed to be done before, during, and/or after the implementation of LSS methodology. For instance, the feedback and level of satisfaction for the integration is highly essential in order to fully assess and/or measure how the new changes have or have not been effective, and thus recognizing how the process works. The categories of “sustainability”, “comparison”, and “statistical analysis” can be observed and performed during and/or after the integration of the LSS methodology. Thereby, all seven categories and their sub-categories assisted in forming the theory for the current study.

6.8 Discussion

According to Lande and Shrivastava (2016), LSS is making a good mark in enhancing the healthcare sector. Numerous healthcare organizations have implemented LSS projects (Ahmed et al., 2018). Generally, the objective has been to improve measures such as safety, efficiency, quality and patient satisfaction, to identify and eliminate waste, to improve clinical processes, and to support staff to examine their workplace (Albliwi & Antony, 2014; Mandahawi et al., 2018). Critical success factors are defined as the essential elements that must be achieved by the organization or project to achieve its mission (Albliwi & Antony, 2014; Jeyaraman & Teo, 2010). The literature review in this paper brings out the shreds of evidence. It points out a significant number of cases in which EDs have failed to sustain the process of deployment for long-term improvements. LSS does incorporate on the lean speed, and impact with a variation control and quality of LSS considered to have high effects. The development of a systematic approach in healthcare organizations to sustain the LSS is necessary.

Noori (2015) states that LSS is linked to the business strategy of the ED in order to improve the performance and the long-term success. Comprehending the ED strategy is essential for optimizing lean programs. The top managers in healthcare are advised to develop and always communicate on the ED improvement strategy as well as preparing a clear strategic deployment plan that shows all the LSS projects (Noori, 2015). A good communication plan with clear guidance and direction is important in deploying the lean six sigma projects. Before any implementation is done, there should be a common understanding between the project managers to decrease unnecessary wastes as well as solving problems concerning them. If they do not come to the position of a clear understanding, then the implementation will be disrupted (Laureani & Antony, 2013). The ED managers are advised to have a common understanding, create challenging visions to give clear directions to the employees of the healthcare, thus delivering an excellent roadmap to better performances and motivating the employees to achieve the best.

Many researchers have also conducted research on the organization culture works when the methods are improved the lean six Sigma has more effects on organizational culture than having the employees being trained in the hospitals. According to Sharma and Chetiya (2012), Organizational structure does encompass the strategies in the people's manner in the ED that can be well considered in the organizational objectives support. The corporate culture of continuous improvement is caused by the results of lean six sigma projects and employee training; both combined an example being the wastes reduction (Sharma & Chetiya, 2012). When a real improvement wants to be noticed, the behavior and understanding of the managers do affect the organizational culture. In the ED, organizational cultures are all about changing on the ways how

the ED staff does behave with the patients, families, and other local companies, generally termed as their customers (Laureani & Antony, 2012; Manville et al., 2012).

For EDs to successfully employ the LSS, they must have a specific management style. Desai and Patel (2012) state that the management system includes the measurement of the performance system, the responsibility management system, and the communication system. The measurement of performance is one of the valuable tools that are specifically for the need for sustainable improvement in healthcare. An increase in discouragements is due to the lack of performance evaluation (Desai & Patel, 2012). After the LSS programs are done, the productivity, time, quality, costs, and waste of the modified process must be accurately measured, and a comparison of the previous process is essential. The success of lean six sigma implementation that is already assessed are usually related to the financial and operational performance measurements.

In his analysis, Dora (2013) states that there is a need for effective communication at horizontal and vertical levels for the success of the LSS project in the ED. A proper communication involving the employees helps in cooperation among them purposely for the LSS scenarios. When there is proper communication, then the ED will have the creation of a common language for positive changes and improvement (Ahmed et al., 2018; Hilton et al., 2008). Frequent communication and assessment on the LSS results in keeping the projects focused on attaining the key goals to cost reduction, elimination of wastes, and variability reduction in the process. There should be regular meetings to review the LSS results and progress, which is done by the steering team committee (Dora, 2013). This will provide a good platform for assessing the areas with the potentiality that needs improvement and gap analysis to bring out the strategies required to achieve the objectives. Poor communication and assessments lead to a misunderstanding of employees,

and the evaluation will lead to a loss of momentum and interest for continuous improvement. A communication plan in the ED is essential in giving an explanation to the personnel who are involved with the LSS to describe the job related and any other benefits from such programs (Laureani & Antony, 2012).

For a successful implementation of LSS in the ED, it is essential for the program's communication of "why's" and "how's" as early as possible to provide peoples opportunities in the improvement of their level of comfort through training classes. In an Empowered productivity forum, which was staged by GE and Microsoft, training programs were concluded as a cornerstone that does improve human input into productivity (Antony & Fergusson, 2004). A LSS training program that is comprehensive gives a provision of the LSS necessary tools, the methodology, and the knowledge towards a systematic approach to solving a problem. A practical LSS training provides a platform for future leaders being well-groomed and equipped with the LSS comprehensive knowledge (Pinedo-Cuenca et al., 2010). Both managers and workers being trained are important and necessary since it provides a communication platform, new organizational strategy, new guidelines, new structures, new tools, new objectives as well as new processes of operation of the healthcare. At times training programs is complicated since it requires many components with various roles to specific approaches and tools (Jeyaraman & Teo, 2010; Psomas, 2016). This needs much emphasis and commitment to improvement and change; thus, it needs a lot of focus on the training. Training is an effective means to project success and sustainability, and it should be on-going progress with continuous efforts.

Management engagement and commitment are critical factors to an effective LSS implementation. In a healthcare organization, the directors and chief executive officers are the top

management; they do play the role of communication of any changes and advising the employees on the positive impact of the new systems (Chakrabarty & Chuan, 2009; Habidin & Yusof, 2013). Management team engagement plays the role of driving continuous improvements, lead as examples, communicating to employees about the goals of the health care, engage in activities, and be committed to driving the LSS culture (Ahmed et al., 2018; Jeyaraman & Teo, 2010; Laureani & Antony, 2012). The upper-level management can send signals that encourage and influence, inspire, and motivate the healthcare layers of organizations to comprehend the importance of the project and work hard to attain the goal. The upper-level management influence the culture, morale of the organization, and participation of the Critical Success Factors for the LSS (Kundu & Manohar, 2012). Without commitment and support from the top management, which is continuing the initiative, importance in health care will be in considerable doubt, and the energy will be easily weakened. The management commitment gives significant meaning and significance to factors such as project management, training, and strategic alignment in the LSS in the healthcare organization (Hilton et al., 2008; Laureani & Antony, 2012; Zhang et al., 2016).

According to Kim (2010), project selection and prioritization are some of the proper criteria's in LSS. When the projects are selected poorly, this leads to a delay in results, causing frustrations. The ED should involve the management of projects such as factors like project selection, initiation, monitoring, measurement, and the right approach and leadership teams (Laureani & Antony, 2012; Mishra, 2018; Kim, 2010). There are business benefits criteria which deal with the impact on external customer requirements to be met up and impact the core competencies. The feasibility criteria deal with the availability of expertise and complexity. The organization's impact criteria deal with the learning benefits of the organization and the cross-

functional benefits that are concerns of new knowledge gained about the business, the processes, and the customers (Psychogios & Atanasovski, 2012). A project tracking system is important in the ED to race all the projects which are submitted purposely for consideration and later accepted for the process of implementation, which are in progress and those completed. Periodic project status tracking is essential to make sure the projects' leaders are able to make the objectives and goals within a specific timeline. There are project mentors who review the project. In contrast, the project leaders help in tracking the status and provision of the guidelines necessary to help the project leaders overcome any roadblocks (Laureani & Antony, 2012; Psychogios & Atanasovski, 2012). The LSS should then be well captured and then placed into project status for the need to track the databases to monitor the status quo that is current.

6.9 Limitations

This study was conducted using purposive sampling of quality experts in an attempt to learn more from their experience from different perspectives. The objective was to gain detailed information via expert opinions in the field and their experiences with the application and research of LSS to improve the ED services. The limitation of this study includes measurement errors which can result from the way the questionnaire has been developed and worded, participant biases, and the low rate of responses. Because the expert study relies on expert opinions and perspectives based on their experience and knowledge, there may be viewpoints on the LSS implementation process that are not identified.

6.10 Conclusion and Future Work

LSS is dedicated to increasing quality, reducing variability and removing any waste from an organization (Albilwi et al., 2014; Bhat et al., 2019). Every decision is made on the foundation of real data and facts. The current study was able to use the GT model to support and implement LSS in EDs, which was recognized as to have challenges for how to improve their processes. This study is an empirical study that synthesizes the experiences of 36 industry and academic experts using survey questionnaire to determine why there is a need to implement the LSS methodology. The study used the responses in gathering the most significant and relevant answers that sums up the seven categories and 42 sub-categories.

The findings revealed seven categories that play an essential role in providing the most beneficial impact in implementing LSS in the ED include: preparation, execution, support, work environment, outcomes, barriers, and measurement. These categories have been observed to show an interconnecting existence and essence. The developed final model is effective and shown the high level of relationship with the given data and facts of the respondents. The current study concluded that by using the developed theoretical model, the process of implementing LSS in the ED becomes much more efficient because the model recognizes the interdependence of factors effecting the process.

This study resulted in seven main categories of factors that could affect Lean Six Sigma implementation in Emergency Departments allowing for significant improvements in ED performance or service to the patients. With the help of the 36 participants, who were all found to be credible and providing a significant value in terms of having relevant expertise with using the

LSS method in healthcare and EDs, this study was able to develop a model grounded in their experience that is specifically developed for the needs of Emergency Departments.

Figure 6.4 below provides a summary of the developed LSS methodology from the grounded theory analysis. The figures provide an easier way to understand the possible process of implementing LSS in the Emergency Department. The process naturally begins with “Preparation”, which is a category of the Core Phenomenon. The category comprises the first steps to take in structuring the project and gathering the relevant factors to consider in implementing the changes. In order to further provide essential support, the presence of the experts and leaders of the healthcare organization should also be considered in the preparation process, which is why the next category highlighted is to determine the “Contextual Conditions” of that healthcare organization. When the support system of the project is fully identified and measured, it will provide a signal as to whether the project would become a success or a failure.

If it happens that both preparation and support factors are sufficiently met, the next step is to determine how the exterior factors would affect the execution of the project. This then leads to determining the “Social Conditions” and “Challenges” that the project may possibly face and find a way on how these will be given a different set of strategy before the proper implementation of the project could proceed. The subcategories under the “Social Condition” are to be given the same priority as what has been provided for the “Contextual Conditions”, because this group will determine whether the execution is likely to be properly executed. Assessing the subcategories provides guidance in developing necessary solutions, allowing the project to effectively be executed when these are all given proper solution. This also true for determining the impact and potential mitigation solution for the category of “Challenges”.

Once these conditions are properly analyzed and addressed in order for the project to proceed, the “Strategies” that directly aim to provide the desired “Consequences” of the project will then be processed. All of the strategies are then be integrated with the desired “Consequences” for the Emergency Department. Lastly, the “Accentuation” are the last stage but will still be perceived to be part of the whole implementation of the LSS project, thereby further refining the process and impact of the whole project.

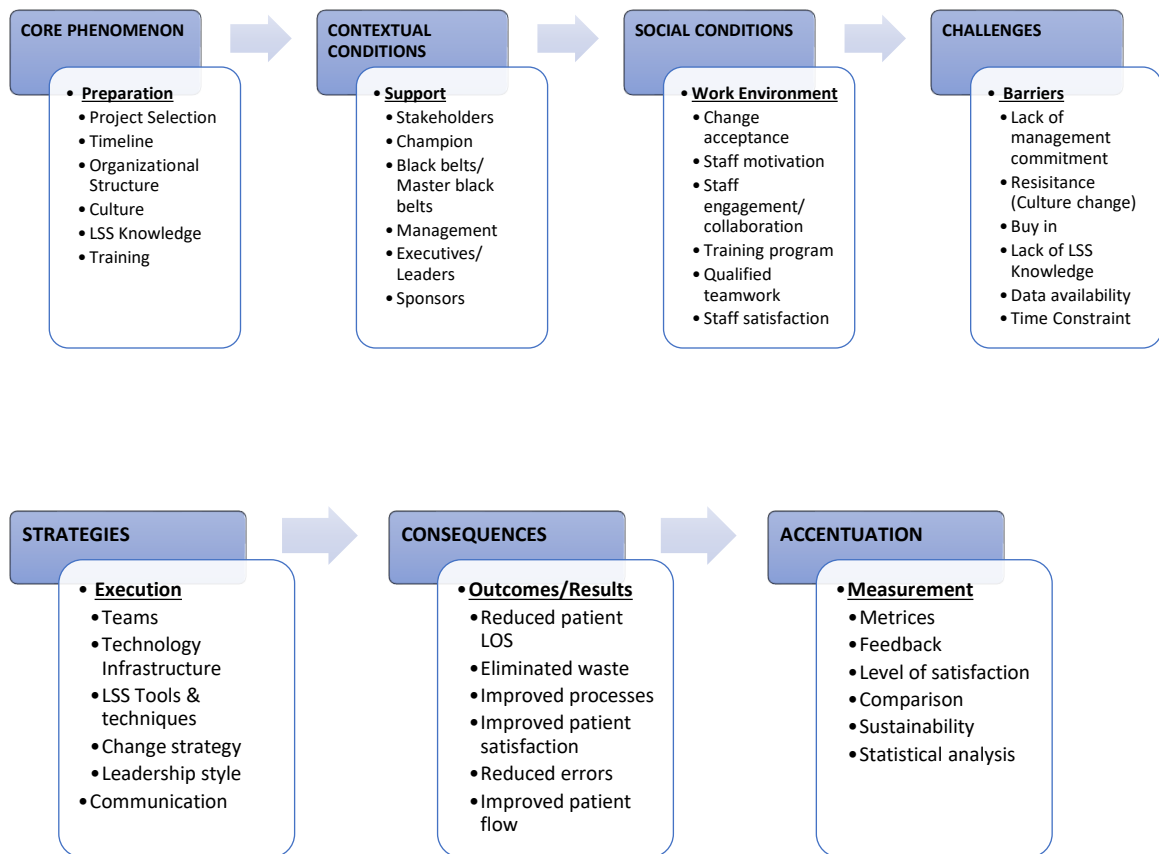


Figure 6.4 A summary of grounded theory model of LSS implementation

This empirical study was able to synthesize the experience of 36 industry and academic experts, thus providing a valuable and distinct contribution to a newly developing research area. If future studies would be able to gather more healthcare industries and experts, it may be observed to be a much more promising future for the healthcare industry, especially in dealing with the most urgent and unexpected cases of the patients.

As a part of future research, a quantitative study will be conducted to investigate the main factors that affect the implementation of LSS in emergency departments. Moreover, quantitative and qualitative survey questionnaires will be conducted to obtain a greater insight into the factors, challenges, and outcomes of LSS implementation in the emergency department. Further, the study intends to develop and implement an LSS theoretical model in order to obtain a greater insight into the LSS for emergency departments.

The theoretical models developed in this study should be properly investigated in the future research including both quantitative and qualitative research methodologies to determine the most suitable methods and tools for the specific issues. For instance, Lean Six Sigma methods are designed to solve issues that will allow an organization to reduce its waste. For Emergency Departments, this can be initiated by identifying the process problems, its root causes, and improvements needed in order for the organization to properly function and offer high-quality service.

In future studies, a data-based approach of using the Lean Six Sigma is needed to establish how effective and powerful this tool is for Emergency Departments, especially where the data is available. However, it is not always used to measure, improve, and control the processes within

the healthcare services. In view of this, the future study can also contribute in providing more possible solutions on how training, education and application of the Lean Six Sigma method could be implemented in order to create a much more credible and relevant solution to identified issues in a patient-centered industry.

6.11 References

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CHAPTER 7: EXPERT STDUY ROUND 2

The Impact of Work Environment on Successful Lean Six Sigma Projects

Note: This chapter is the first manuscript of this dissertation and an appropriately formatted version is planned to be submitted to Total Quality Management & Business Excellence (IF=2.66) on July 31, 2020.

7.1 Abstract

Purpose – The purpose of this study is to determine the latent constructs of the elements of work environment in Lean Six Sigma (LSS) implementation in emergency departments (ED). In addition, this study investigates the relationship between elements of work environment and factors that affect successful Lean Six Sigma projects in ED.

Design/methodology/approach – A quantitative survey questionnaire was used to gather data, which was conducted among 230 quality healthcare experts with 0.21% usable responses. Exploratory Factor Analysis (EFA) is applied to determine the underlying structure of elements of work environment in LSS projects, as well as Cronbach's alpha to measure the internal consistency and reliability of the developed constructs. Bivariate correlation is also used to formulate the relationship between the elements of work environment factors and successful LSS projects, outcomes, and sustainability.

Findings – The EFA results show that only one component was extracted, which suggests that all items fit onto a single theoretical construct, with alpha coefficient of 0.89. Thus, the rotation with

factor analysis was not needed to be conducted. The descriptive analysis of the elements of work environment shows the significance results. A bivariate correlation results indicated to statistically significant results with a weak relationship between the elements of work environment and the overall success of LSS projects, the achievement of outcomes of LSS, and the sustainment of outcomes.

Research limitations/implications – The small sample size of the quality healthcare experts is a limitation of this study. However, the participants were all experts in this field with an average of 10 years of experience in HC quality. Further, the sample was sufficient to achieve an acceptable level of statistical power for all tests and models. Based on these limitations, the larger-scale survey using the refined the elements of work environment construct as well as multi-item constructs for all CSFs could be conducted for future research.

Originality/value – This study contributes to the literature by identifying the underlying structure and the significance of work environment factors on LSS implementation success. Additionally, this study is valuable for healthcare professionals as a guideline to achieve the successful implementation of LSS implementation in EDs.

Keywords Lean Six Sigma, Emergency department, Survey research, Construct development, Work environment, Critical success factors.

7.2 Introduction

Lean Six Sigma combines two popular management philosophies: Lean and Six Sigma (Lee & Su, 2013). Each management philosophy has gained considerable popularity and believed to complement each other (Sunder, 2013). Lean principle in particular is based on the assumption

that costs could be reduced and product flow could be improved through the elimination of all non-value adding activities or wastes (Gremyr and Fouquet, 2012). The Lean movement seeks to eliminate waste, increase productivity, and enhance quality (Manoway, 2015). Six Sigma on the other hand has been referred to as a structured approach that emphasizes the detection and elimination of defects, mistakes, or failures in business processes or systems by focusing on certain process performance characteristics that are vital to the customers (Kumar, Antony, Madu, Montgomery & Park, 2008). It is recognized as a serial analytical and statistical method for eliminating process variations and obtaining breakthrough improvements in product or service quality (Lee & Su, 2013). Combined, Lean and Six Sigma create a synergy that yields far greater benefits including reduces hands-off and improves process flow, reduces both process waste and process variation, and eliminating the root cause of the problem (Sunder, 2013). On the other hand, LSS approach can improve succession planning, provide rights roles to the right peoples, provide correctly training programs, and, provide high levels of job satisfaction (Stevens, 2008). However, assumption is that successful implementation of LSS requires certain conditions in the work environment. This paper looks at the impact of work environment on LSS implementation. The goal of the paper is to discuss how the elements of work environment such as staff motivation, job satisfaction, training, teamwork, communication, and engagement and collaboration contribute to the successful implementation of LSS. Consequently, the purposes of this paper are as follow:

- 1- Review the literature relating the key characteristics of LSS and the critical success factors (CSFs) of successful implementation, as well as the impact of work environment factors on the implementation.

- 2- Determine the critical success factors (CSFs) of LSS implementation in the EDs through a questionnaire survey and descriptive statistics.
- 3- Identify the key principle factors of work environment using exploratory factor analysis (EFA) approach and scree plot criteria, as well as test the reliability using Cronbach's alpha for work environment elements.
- 4- Investigate the relationships between the work environment factors and the successful LSS projects, the achievement of outcomes of LSS, and the sustainability of outcomes, via a questionnaire survey and correlation analysis.

7.3 Background

This section first reviews the state of research in regard to the impact of work environment on LSS in EDs. In doing so, the literature of LSS in healthcare is first reviewed. There is also a review on the critical success factors of LSS in healthcare before delving into the impact of work environment factors on LSS implementation.

7.3.1 Lean Six Sigma in healthcare

Lean Six Sigma (LSS) is among the most reliable performance improvement methods used across different organizations, including hospitals (Laureani et al., 2013; Alcaide-muñoz & Gutierrez-Gutierrez, 2017). Toyota is among the first companies to use LSS in the manufacturing industry to improve efficiency and effectiveness of the production process (Antony et al., 2017). In fact, during the 1950s, the LSS was known as the Toyota Production System (Antony et al., 2017). LSS is composed of the Lean, which focuses on efficiency and effectiveness that deals with

effectiveness (Sharma, 2003). The Six Sigma targets to enhance quality by minimizing variation (Shah et al., 2008). On the other hand, the Lean philosophy eliminates wastes, thereby promoting smoothing, and accelerating the flow (Laureani and Antony, 2012). LSS is a powerful tool that has been successfully applied in many areas to improve productivity (Lee & Wei, 2009; Chen & Lyu, 2009).

In the healthcare sector, the objective of applying the LSS is to eliminate the defects observed (Laureani et al., 2013). The LSS is essential in improving patient safety through prevention of errors. Through LSS, it is possible to improve the processes within the emergence department. For instance, LSS can be used to minimize the length of patient stay in the emergence department, prevent time wastage, improve the treatment process, and increase patient satisfaction (Furterer, 2018; Laureani et al., 2013). Furthermore, LSS ensures consistency in attending to patients in the emergency department while promoting delivery of patient-centered care (Furterer, 2018; Laureani et al., 2013). The approach helps to eliminate most of the unnecessary steps that could delay delivery of the desired services (Trakulsunti & Antony, 2018).

7.3.2 Critical success factor of Lean Six Sigma in healthcare

Within the healthcare setting, there are a number of critical success factors (CSFs) that have continuously determined and affected the implementation of LSS as a tool for attaining both quality management and culture change. These CSFs simply refer to actions, measurements, roles, responsibilities, and behaviors that leaders apply in their quest to effectively use LSS to reduce waste within health processes (Laureani & Antony, 2018). Based on the conceptual framework of CSFs (Figure 5.2), ten main CSFs have been identified in relation to LSS, Table 7.1 (Lande et al.,

2016). Executive engagement and management involvement as a CSFs refer to the extent to which top executives and management members are ready to support the overall drive to minimize waste (Laureani & Antony, 2018). Their involvement has been come in many different forms but mainly through their readiness to make resources available for the LSS implementation. Communications also refers to the effective way of making information available to all employees within the organization, including setting clear rules of engagement that aims at eliminating waste (Marzagão & Carvalho, 2016). What is more, resources are identified as CSFs because they are what health facilities use in actually carrying out service delivery. The resources are not only tangible one but also include time and training. Finally, discipline is needed across all sectors of the workplace to ensure adherence to rules pertaining to efficient implementation of healthcare delivery.

7.3.3 Impact of work environment factors on Lean Six Sigma implementation

As noted above, there are CSFs that affect the successful implementation of LSS. Meanwhile each of the CSFs apply within the organizational context, making the work environment critical to the implementation process. Honda et al. (2018) therefore posited that the work environment as an entity therefore has the potential of directly affecting the LSS implementation. Several factors within the work environment have been pointed out as having the potential of impacting on Lean Six Sigma implementation. Holmberg et al. (2016) alluded to the fact that staff motivation and job satisfaction are necessary for them to have a sense of assurance that their effort towards eliminating waste, improving service quality, and fostering culture change will be recognized and rewarded. Honda et al. (2018) also asserted that the LSS is a model that is

expected to be part of the professional lifestyle of employees. For this reason, staff training is an important work environment factor that directly affects the implementation of LSS. What is more Krueger et al. (2017) advocated the need to utilize teamwork, effective communication and collaboration at the work place to achieve the goals of LSS? This is because teamwork, effective communication and collaboration all work together in enhancing efficiency and maximizing productivity within the healthcare setting (Krueger et al., 2017).

7.4 Research Methodology

The study adopted a quantitative method involving questionnaire survey. Quantitative approach emphasizes the statistical, numerical, or mathematical analysis of data collected through surveys and questionnaires (Neuman, 2014). Survey is a structured way of asking the same questions to different respondents to understand the situation being studied from different perspectives (O’Gorman and MacIntosh, 2015). In this phase, the quantitative survey has been developed based on the results from two independent syntheses, the Content Analysis (Chapter 5) and the Expert Study (Chapter 6). Thus, the purpose of this study is to investigate the CSFs of LSS (Figure 5.2), quantify the effects of the elements of work environment (Figure 6.3), and investigate the relationships with LSS project success.

To obtain quantitative data, a questionnaire used as a survey instrument. The questionnaire consists of two main sections. The first section of the survey aimed to understand general demographic information about the participants by series of close and multiple-choice questions. The second part used a five-point agreement Likert Scales (i.e., 1= strongly agree 2= agree 3= neutral 4= disagree 5= strongly disagree), as well as five-point extent Likert Scales (i.e., 1= Not at

all 2= Very little extent 3= To some extent 4= very large extent 5= To a great extent) (Bishop & Herron, 2015).

Based on these scales, the participants were asked to indicate the degree of agreement to which they agree with different provided statements related to three parts: factors that affect successful implementation (Table 7.1), outcomes of implementation success, and the impact of work environment on achievement of outcomes. The participants were asked to consider the most recent LSS project that they participated in or directly observed in an ED. An example of the questions participants were asked in the following: “Considering the last LSS project that you participated in or observed in an ED, to what extent do you agree with the following statements? The ED staff received adequate training for their job”.

The questions were pilot tested by five quality healthcare experts to ensure its clarity and effectiveness in fulfilling the purpose of the study (Sincero, 2012). The initial draft of the questionnaire was revised based on the recommendations of the experts. Therefore, the validity of questionnaire’s content is ensured. The questionnaire was conducted as a web-based survey and hosted at online survey platform in May and June 2020. The survey data were analyzed using Microsoft Excel and SPSS.

Table 7.1 CSFs of LSS implementation

Critical success factors of LSS	Supporting literature
Management commitment and involvement	Hilton et al. (2008), Antony and Desai (2009), Kumar et al. (2009a), Aboelmaged (2010), Jeyaraman and Teo (2010), Soti et al.(2010), Lee et al. (2011), Laureani and Antony (2012), Manville et al. (2012), Cheng (2013),

Critical success factors of LSS	Supporting literature
	Ismyrlis and Moschidis (2013), Albliwi et al. (2014), Carvalho et al. (2014), Ribeiro et al. (2015), Laux et al. (2015), Zhang et al. (2016), Ahmed et al. (2018), and Mishra (2018).
Organizational cultural	Antony and Desai (2009), Kumar et al. (2009b), Soti et al. (2010), Aboelmaged (2010), Jeyaraman and Teo (2010), Mehrjerdi (2011), Lee et al. (2011), Desai et al. (2012), Suresh et al. (2012), Laureani and Antony (2012), Manville et al. (2012), Prashar (2014), Carvalho et al. (2014), and Zhang et al. (2016).
Linking LSS to business strategy	Antony and Desai (2009), Aboelmaged, (2010), Mehrjerdi (2011), Lee et al. (2011), Desai et al. (2012), Laureani and Antony (2012), Manville et al. (2012), Cheng (2013), Carvalho et al. (2014), Ribeiro et al. (2015), and Laux et al. (2015).
Linking LSS to customers	Hilton et al. (2008), Antony and Desai (2009), Aboelmaged (2010), Lee et al. (2011), Laureani and Antony (2012), Manville et al. (2012), Cheng (2013), Carvalho et al. (2014), Laux et al. (2015), and Ahmed et al. (2018).
Project selection and prioritization	Antony and Desai (2009), Kumar et al. (2009), Aboelmaged (2010), Jeyaraman and Teo (2010), Lee et al. (2011), Laureani and Antony (2012), Manville et al. (2012), Cheng (2013), Albliwi et al. (2014), Carvalho et al. (2014), Ribeiro et al. (2015), Laux et al. (2015), and Mishra (2018).
Communication plan	Hilton et al. (2008), Kumar et al. (2009), Aboelmaged (2010), Jeyaraman and Teo (2010), Laureani and Antony (2012), Manville et al. (2012), Cheng (2013), Albliwi et al. (2014), Carvalho et al. (2014), and Ahmed et al. (2018).
Training program	Hilton et al. (2008), Antony and Desai (2009), Kumar et al. (2009b), Aboelmaged (2010), Jeyaraman and Teo (2010), Mehrjerdi (2011), Lee et al. (2011), Desai et al. (2012), Antony et al. (2012), Manville et al. (2012), Ismyrlis and Moschidis (2013), Laureani and Antony

Critical success factors of LSS	Supporting literature
	(2012), Gijo et al. (2014), Albliwi et al. (2014), Carvalho et al. (2014), Ribeiro et al. (2015), and Laux et al. (2015)
Organizational structure	Hilton et al. (2008), Antony and Desai (2009), Kumar et al. (2009), Soti et al. (2010), Aboelmaged (2010), Desai et al. (2012), Laureani and Antony (2012), Manville et al. (2012), and Carvalho et al. (2014).
LSS tools and technoques	Hilton et al. (2008), Aboelmaged (2010), Soti et al. (2010), Firka (2010), Mehrjerdi (2011), Lee et al. (2011), Antony et al. (2012), Laureani and Antony (2012), Manville et al. (2012), Ismyrlis and Moschidis (2013), Mehrjerdi (2013), Carvalho et al. (2014), and Laux et al. (2015), and Ahmed et al. (2018).
Project management skills	Hilton et al. (2008), Laureani and Antony (2012), Manville et al. (2012), Carvalho et al. (2014).

7.4.1 Sample size

The criterion for selecting the participants who would participate in the study was their experience in quality healthcare, specifically in LSS implementation in emergency departments. Experts from Round 1 of the Expert Study (Chapter 6) were invited to participate in this Study. In addition, new participants were invited to participate in order to expand the sample of experts to ensure a sufficient sample size. The two samples were compared using t-test and the results showed that there were no significant differences in the means of profession experience, year of experience, level of success, and outcomes between between the two samples. This result suggesting that the two samples could be combined for a single analysis. The structured questionnaire have been distributed by email, which includes direct survey link, to 230 people, which included academic

researchers, administrative professionals, medical professionals, and consultants. Two follow-up reminder emails were sent in two weeks after the initial e-mailing.

Over the decades, the issue of minimum sample size for EFA has received significant attention owing to the sensitivity of EFA to the sample size (MacCallum et al., 1999; Tanaka, 1987). There is also a significant range of guidelines associated with a sufficient sample size provided in the factor analysis literature. In most cases, these guidelines recommend sizeable samples (suppose a minimum sample size of 200) to acquire sufficient statistical power. Nonetheless, data sets associated with smaller samples are regularly conducted in the behavioral and social analysis (MacCallum & Austin, 2000). In the medical sciences, it is sometimes too burdensome to gather a substantial sample of patients suffering from a specific disease. The sampling units in management studies often correlate to products or firms, hence making it difficult to obtain large sample sizes (MacCallum & Austin, 2000). The minimum sample size for studies conducting EFA should not be below 30 in any case (Greenweed & Sandomire, 1950). Generally, EFA requires 5-10 observations per item. There are six items of work environments in this study suggesting that the minimum sample to conduct an EFA to refine this construct is 30-60 participants. Note that 49 participants out of 230 completed the questionnaire, a response rate of 21.30 %, which falls in the acceptable range and can be considered a valid number to achieve valid statistical model (Greenweed & Sandomire, , 1950).

7.4.2 Data analysis

EFA is applied to extract the latent constructs of the work environment factors. EFA also used to classify the structure of the relationship between the variable and the respondent. The principal component factor extraction method and the direct oblimin rotation method is used

(Gunday et al., 2011). CFA is conducted to test whether measure of a construct is consistent with a researcher's understanding of the nature of that construct. Reliability analysis or “Cronbach’s alpha” of the latent constructs was also used to measure the internal consistency or reliability by calculating the Cronbach’s α coefficients (Sadikoglu and Zehir, 2010). According to Cramer (1998), “reliability is particular important in connection with multiple item scales”. The Cronbach’s α coefficient was calculated using SPSS software; an alpha coefficient of 0.7 or higher is considered an acceptable level of internal consistency. The Bivariate correlation approach used to formulate the relationships between the elements of work environment and the successful LSS projects, the achievement of outcomes of LSS, and the sustainability of outcomes. Lastly, The mediation analysis (Lapointe-Shaw et al., 2018; Robins & Greenland, 1992) was conducted to test whether the relationship between the two variables (LSS factors and achievement of outcomes) is explained by the third intermediate variable (work environment).

7.5 Discussion of Results

The survey results are presented in two parts. First, the demographic information of the participants and information about participants’ experience when implementing LSS in an ED is discussed. Then, the quantitative evaluation of the CSFs of LSS implementation, outcomes of implementation success, and the impact of work environment on the LSS implementation is described.

7.5.1 Demographic information

The analysis of the first part of the questionnaire provided a better understanding about participants’ background and experience.

Profession. Table 7.2 shows that the majority of respondents (49%) were an academic researchers - who have journal publications in LSS in ED. There were 14.3% Administrative professionals - who were implemented or responsible for applying Lean Six Sigma in ED, 18.4% medical professionals, and 16.3% consultants . These results suggest that, although the sample is dominated by academic researchers and consultants, there is still some representation from hospital staff.

Years of experience. Out of the 49 participants, 6.1% participants have quality experience less than one year, 22.4% ranging from 1 – 5 years, and 30.6% have about 5 – 10 year. All other participants (44.8%) have experience for more than 10 years. Overall, most participant have had a fairly good experience with Lean Six Sigma implementation. The average years for experience are 10, which consists of 40.8% of the study population. This suggests that the sample is sufficient for this study because most of the respondents have significant experience with using the LSS.

Training/certification. 34.7% of participants were certified with Master Black Belts, 34.7% Black Belts. (14.3%) Green Belts, (2%) Yellow Belts, and (12.2%) have no certifications. The findings imply that a large percentage of the respondents have been trained, thereby making it easy for them to respond appropriately to the study questions and provide reliable results.

Number of LSS projects in ED. 46.9% participants have implemented 1 to 5 LSS projects, while 18.4% implemented 6 to 10 projects. 11 – 20 project (14.3%) participants, 21 – 30 projects (10.2%) participants, and more than 30 projects (10.2 %) participants. All participants had experience with implementing LSS projects with the highest category having implemented 11-20

projects. Therefore, the responses given in the questionnaires are based on the respondents' experiences when implementing the LSS.

Table 7.2 Participant demographic information

	(%)
<i>Profession</i>	
Academic researchers	49
Administrative professionals	14.3
Medical professionals	18.4
Consultants	16.3
Other	2
<i>Years of experience</i>	
Less than one year	6.1
1 – 5 years	22.4
5 – 10 years	30.6
More than 10 years	40.8
<i>Training/certification</i>	
Master Black Belt	34.7
Black Belt	34.7
Green Belt	14.3
Yellow Belt	2
No certification	12.2
Other	2
<i>Number of LSS projects</i>	
1– 5 projects	46.9
6 – 10 projects	18.4
11 – 20 projects	14.3
21 – 30 projects	10.2
More than 30 projects	10.2

Implementation success rate. The participants were also asked to use a five-point Likert scale to rate the implementation success in emergency departments based on their experience with the last

implementation of LSS they participated in or observed, where 1= completely successful, 2= somewhat successful, 3= moderately successful, 4= somewhat unsuccessful, and 5= completely unsuccessful. Figure 7.1 below summarizes the results, which indicated that all LSS projects were reportedly successful with different rates: 69.4% of projects were completely successful, 24.5% of projects were somewhat successful, and 6.10% of projects were considered as moderately successful. On the other hand, zero unsuccessful projects were reported. However, the lack of a representation of unsuccessful projects could be an indication of a reporting bias from some of the participants. Despite the level of experience on LSS, implementing such projects require teamwork and are generally associated with errors likely to influence failure. These findings suggest that the strength of LSS implementations in EDs help to improve the effectiveness of the organization. According to Snee (2010), successful projects are usually the best way to reduce barriers to implementation. Based on these findings, it will be possible to achieve a high success rate when implementing the LSS project. However, not all projects can achieve 100% success.

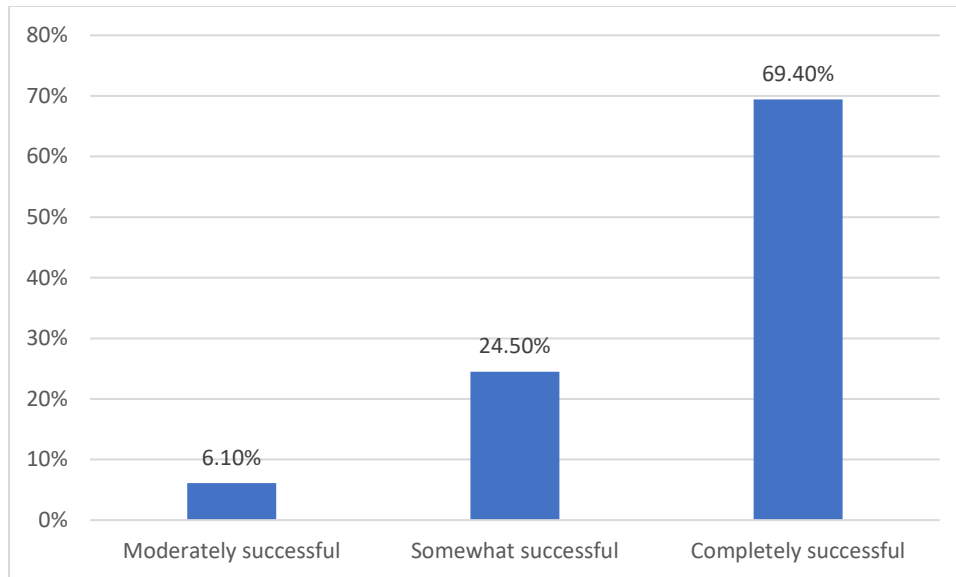


Figure 7.1 Success rate of LSS projects

It is important to note that this result indicates the success of the most recent LSS projects that experts participated in or observed in an ED and the participants' level of experience and expertise may have affected the associated success rate. The implementation of LSS depends on the critical success factors which have been described in the following section.

7.5.2 CSFs of LSS implementation

The participants were asked to score the CSFs that facilitated and supported the implementation of LSS in EDs using five-points Likert scale, where 1= strongly disagree, 2= disagree, 3= neutral, 4= agree, and 5= strongly agree. The objective was to determine which factors the LSS implementers deemed to be important, as a factor with the heights mean score is considered as the most important factor. Figure 7.2 shows the results, where "management

commitment and involvement” is considered the most important, followed by “organizational cultural”, “LSS tools and techniques”, and “Linking LSS to business strategy”.

The findings are similar to several earlier studies (Ahmed et al., 2018; Laureani and Antony, 2012; Snee, 2010; Zhang et al, 2016), all of which placed “management commitment” as the top CSF, also indicating some of the other CSFs listed above. Furthermore, participants do not consider “project timeline”, “project selection and prioritization”, “organizational structure” and “technology infrastructure” as important factors for successful LSS implementation. The findings confirm arguments in the literature that the most important factor when implementing these projects is the management’s commitment to ensuring LSS becomes a success. Medical and quality professionals, therefore, need to work closely with the management throughout the LSS implementation phase. Through these relationships, it will be possible to address any barriers likely to prevent project implementation.

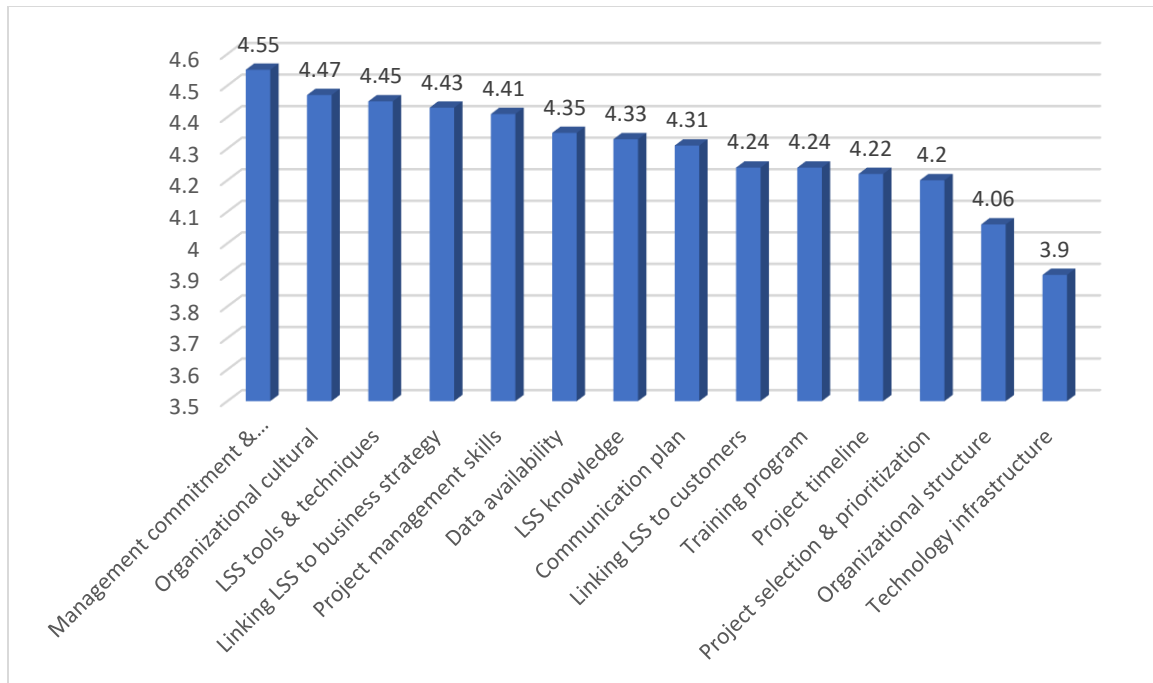


Figure 7.2 CSFs of LSS projects

A high number of the participants agree that managers are highly committed to the LSS projects, which were also observed to have a high average overall success rating. Other factors that received high scores are organizational culture, LSS tools, and techniques, linking LSS to business strategy and program management skills. However, the factors participants did not observe when implementing the projects include organizational structure and technology infrastructure. A poor organizational structure has been identified among the factors that prevent success of the LSS projects. Besides, most of the LSS projects require IT infrastructure. Therefore, lack of the IT infrastructure could fail to yield the desired outcome. In this case, however, the experts observed that although their projects had less than ideal IT infrastructure, it did not necessarily make it difficult to achieve the desired results.

7.5.3 Outcomes of LSS implementation success

The participants were asked to select the outcomes and benefits that LSS had brought to the emergency department since implementation from multiple choices on a given list, Figure 7.3 below summarizes the results. It is encouraging to see the areas that have experienced the greatest outcomes and benefits, The average of 4.06 of the implementers were able to improved patient satisfaction, 4.19 improved clinical care outcomes, 4.02 reduces patient length of stay, 4.02 reduced errors, 3.24 improved ED staff performance, 3.41 improved patient safety, 3.67 improved reputation of the ED, 4.31 improved patient flow, and 4.49 eliminate waste. These findings are similar to several earlier studies (Hilton and Sohal, 2012; Laureani and Antony, 2010; Zhang et al., 2010), all of which indicated the same and some of the other benefits listed in the figure. Therefore, hospitals should consider implementing LSS projects in the emergency department to improve patient flow, increase safety, enhance staff performance, prevent clinical errors, and eliminate wastes including time wastage.

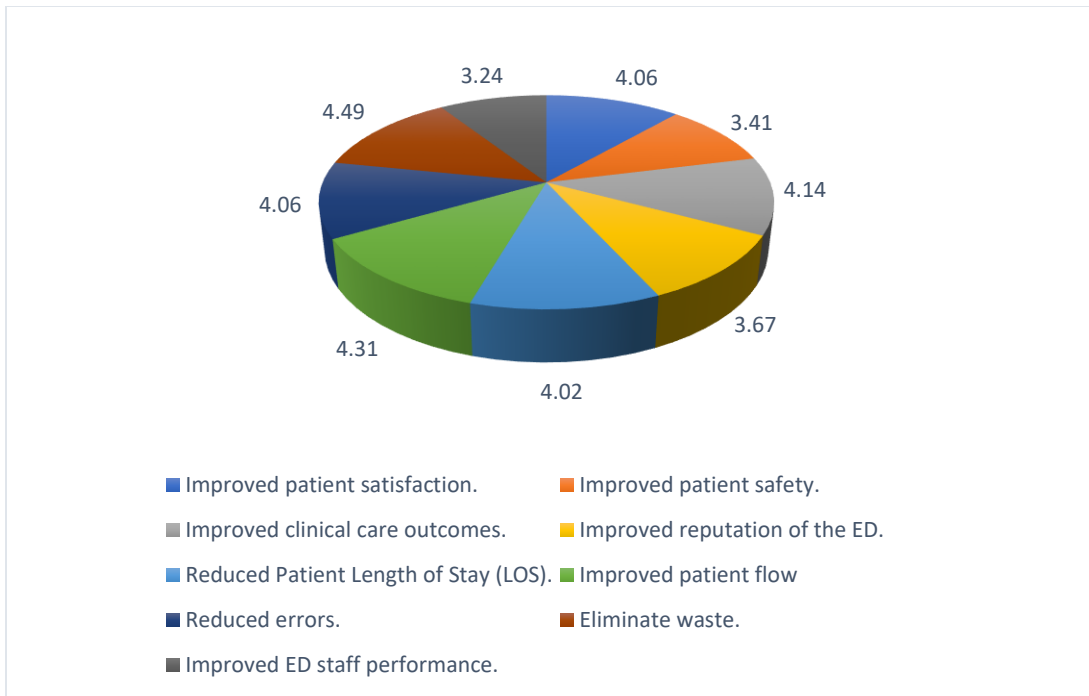


Figure 7.3 Benefits and outcomes of LSS

As indicated in Figure 7.3, the leading benefit is elimination of wastes, followed closely by improved patient flow and improved clinical outcomes. The impact on the reduction of errors and improved patient satisfaction is also the same. The least observed benefit is improved reputation of the ED.

7.5.4 The impact of work environment on the LSS implementation

The statistical analysis results explain the impact of work environment factors on Lean Six Sigma implementation in the emergency department. The results explain the relationship of the elements of environmental work with the overall success, achievement of outcomes sustainment of outcomes. The elements of work environmental, including staff motivation, staff training, job

satisfaction, teamwork, communication, staff engagement, and collaboration, are also analyzed to determine the relationship between the factors on lean sigma implementation in the emergency department. The work environment has a mean of 4.3, whereas the mean of successful LSS projects is 4.6. On the other hand, the respective means for achievement of outcomes and sustainability of outcomes is 3.9 and 3.8, respectively, Table 7.3.

Table 7.3 Descriptive statistics

	Mean	Std. Deviation	N
Work environment	4.2993	0.60856	49
Overall success	4.6327	0.60187	49
Achievement of outcomes	3.9342	0.72575	49
Sustainment of outcomes	3.8639	0.73607	49

Exploratory factor analysis

One of the most popular methods of estimation in exploratory factor analysis is Principal Axis Factoring (PAF). Nevertheless, there is no substantial evidence to identify the method which is best suited for divergent types of sample sizes and factor patterns (Costello & Osborne, 2005). PAF was conducted to establish an initial common variance estimate whereby the communalities were less than 1. This estimate presumes that the community of each variable with respect to other variables is equivalent to the coefficient of square multiple regression. Fabrigar et al. (1999) suggest that a principal factor method is recommended in case the presumption of multivariate normality is considered as “severely violated”; in SPSS, this procedure is referred to as the

principal axis factor. According to Costello and Osborne (2005), the outcome of PAF will be best for identifying latent constructs based on whether the data is significantly non-normal or normally distributed. Further, an oblique rotation was used as the potential latent factors within WE are likely to be correlated.

Table 7.4 shows the means and the standard deviation values of the six elements of work environment. The standard deviation values are ranging between 0.67 and 8.84, which are almost close. Since these standard deviation values are relatively high, this means that there is a high dispersion among all the elements of work environment, Osborne, et al. (2014).

Table 7.4 Descriptive statistics for elements of work environment

	Mean	Std. Deviation
Staff motivation	4.3061	.76931
Staff training	4.2653	.88448
Job satisfaction	4.1633	.82530
Teamwork	4.4082	.67449
Communication	4.3061	.68325
Staff engagement & collaboration	4.3469	.72316

Table 7.5 presents the Kaiser-Meyer-Olkin (KMO) test, which measures the suitability of the data in factor analysis (Hill, 2011). Since the KMO value is 0.83, the sample is adequate in the test. Nonetheless, Bartlett's test is significant, which means we have at least one significant correlation – at least two items are highly correlated (Reddon & Jackson, 1984). The approximate chi-square is 155.68, with 15 degrees of freedom, which is significant at 0.05 level of significance. The KMO statistic of 0.84 is also larger than 0.5; hence the factor analysis is considered appropriate for further data analysis (Tobias & Carlson, 1969).

Table 7.5 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.835
Bartlett's Test of Sphericity	Approx. Chi-Square	155.675
	df	15
	Sig.	.000

Only one factor in the initial solution has an eigenvalue greater than 1. The results of EFA indicate that only one component explains about 64.54% of the variability in the original variable (see table 7.6). However, the remaining percentage is about 55%, which is accumulative variability explained by the one factor. The difference in the two values is about 10%, which explains the variation lost due to latent factors unique to the original variables and cannot be explained by the factor model.

Table 7.6 Variance in EFA

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.873	64.543	64.543	3.873	64.543	64.543
2	.675	11.245	75.788			
3	.497	8.291	84.078			
4	.432	7.206	91.284			
5	.370	6.160	97.444			
6	.153	2.556	100.000			

Figure 7.4 illustrates the scree plot graphs the Eigenvalue against each factor. This plot agrees with what we got in the above table. It is evident that there is one component that has Eigenvalues greater than 1. So, the results indicate that we have one distinct construct, and the rest of the values lie below one.

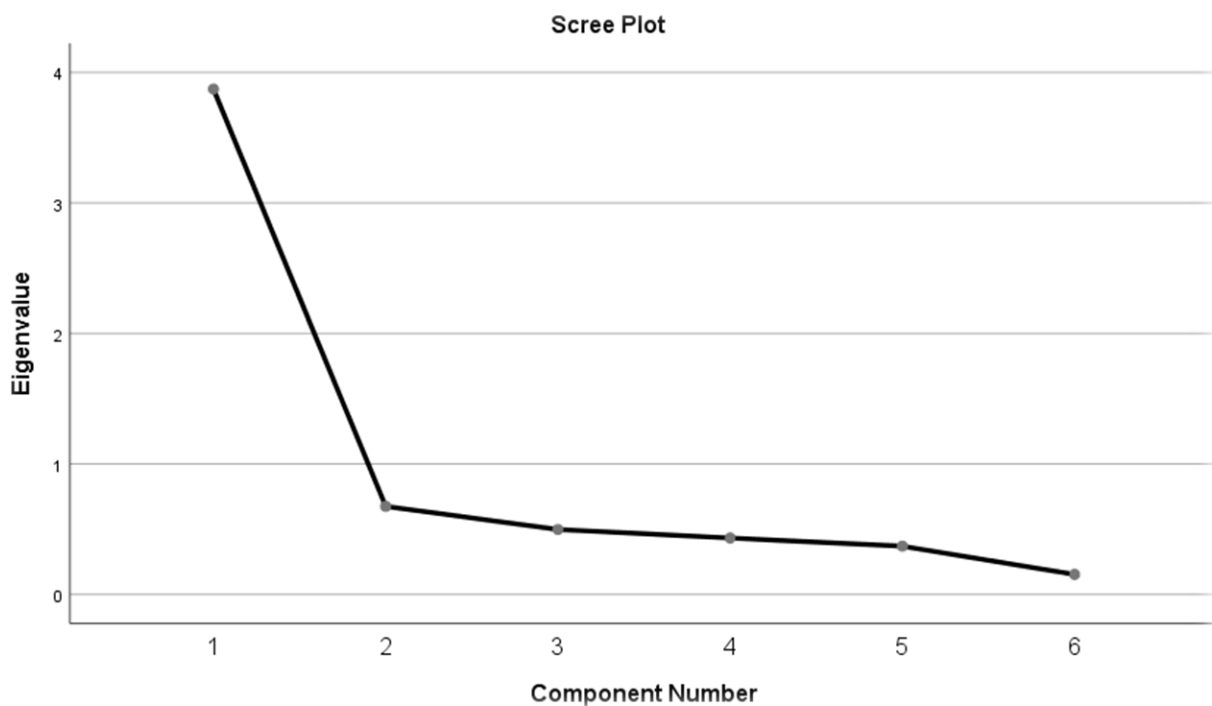


Figure 7.4 Scree Plot

Table 7.7 Component Matrix

	Component 1
Staff motivation	0.755
Staff training	0.791

Job satisfaction	0.828
Teamwork	0.881
Communication	0.843
Staff engagement & collaboration	0.710

Component matrix (Table 7.7) presents the correlation of each work environment factor with the component. Each element of the work environment has a loading corresponding to the 1 component: staff motivation (0.75), staff training (0.79), job satisfaction (0.82), teamwork (0.88), communication (0.84) and staff engagement and collaboration (0.71).

Cronbach’s alpha for work environment factors

According to Santos (1999), Cronbach’s alpha measures the internal consistency and reliability. We have 49 participants and 6 items that they responded to on a five-point Likert scale. The alpha coefficient for the six elements of work environment, with conducted “item removed” option”, is 0.89, suggesting that the factors have relatively high internal consistency, as it is greater than 0.7 (Sharma, 2016). It should be noted that deleting any element of work environment will make the Cronbach’s alpha weaker (e.g. deleting staff motivation element will lower the Cronbach’s alpha to be 0.873, Table 7.8).

Table 7.8 Reliability statistics if item deleted

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Staff motivation	21.4898	9.630	.651	.873
Staff training	21.5306	8.921	.687	.869

Job satisfaction	21.6327	9.029	.730	.860
Teamwork	21.3878	9.534	.803	.851
Communication	21.4898	9.672	.752	.858
Staff engagement & collaboration	21.4490	10.044	.603	.880

Bivariate Correlation Analysis

One of the research aims is to understand whether work environment factors affect the overall success LSS projects, the achievement of outcomes of LSS, and the sustainment of outcomes. Bivariate correlation analysis was used to investigate whether any correlations exist.

The null hypotheses have been formulated as following:

$H1_0$: There is no relationship between work environment factors and the overall success of LSS projects.

$H2_0$: There is no relationship between work environment factors and achievement of outcomes.

$H3_0$: There is no relationship between work environment factors and the the sustainment of outcomes.

A Pearson product-moment correlation coefficient was conducted to evaluate the first null hypothesis (N= 49). Table 7. 9 presents the descriptive statistics and the correlation test results for all variables.

Table 7.9 Correlation test results

		Work environment	Overall success	Achievement of outcomes	Sustainment of outcomes
Work environment Factors	Pearson Correlation	1	.354*	.463**	.330*
	Sig. (2-tailed)		0.013	0.001	0.021
Overall success	Pearson Correlation	.354*	1	0.262	0.198
	Sig. (2-tailed)	0.013		0.07	0.172
Achievement of outcomes	Pearson Correlation	.463**	0.262	1	.870**
	Sig. (2-tailed)	0.001	0.07		0
Sustainment of outcomes	Pearson Correlation	.330*	0.198	.870**	1
	Sig. (2-tailed)	0.021	0.172	0	

Correlation between work environment factors and the successful LSS projects. There was significant evidence to reject $H1_0$ and conclude that there was a strong positive association between work environment (Mean = 4.29, SD= 0.60) and the successful LSS projects (Mean = 4.63, SD= 0.60), $r(49) = 0.354$, $p < 0.05$. This result indicated that the work environment is statistically significantly and has a weak relation associated with the successful LSS projects. Therefore, a supportive work environment will lead to the successful implementation of the LSS project. However, if the work environment factors are not favorable, then it could be challenging to implement the LSS project successfully.

Nevertheless, management commitment towards LLS practices is positively related to company financial performance at a 5 % significance level. Possessing commitment that is on top, aligning its business goal of maximizing profit assists in ensuring the implemented LSS projects meet the objectives as well as achieve significant business cost-saving (Ali, Choong & Jayaraman, 2016). More importantly, the financial capability of the organization in the implementation of LSS is found not related to overall business performance, regardless of financial and non-financial performances. Moreover, resource allocation is positively related to operational performance at a 5 % significance level. Having more resources allocated into LSS improvement projects, the operation performance of the company is improved as a result of the direct impact in the relationship. There is no effect of operational performance on the relationship between the allocation of resources and the financial performance of the business.

Furthermore, the top management support as a key driver towards successful deployment as well as the implementation of the LSS project (Ali, Choong & Jayaraman, 2016). According to Galloway (2006), top management support has a positive relationship between LSS success and financial impact on the company.

Correlation between work environment factors and achievement of outcomes. There was significant evidence to reject $H2_0$ and conclude that there was a strong positive association between work environment factors (Mean = 4.29, SD= 0.60) and achievement of outcomes (Mean = 3.93, SD= 0.72), $r(49)= 0.463$, $p < 0.01$. This result indicated the work environment is statistically significantly and has a low to moderate relationship associated with the achievement of outcomes. The achievement of outcomes also depends on the work environment. If the work environment is

favorable, the implementation of the LSS will result in positive outcomes. However, unfavorable environmental factors could make it difficult to achieve the targeted outcome when implementing the LSS project.

The physical work environment refers to a persons' to fit or misfit to the environment of the workplace. According to various studies, researches regarding the workplace environment need to be done to get an ergonomic workplace for every each of the employees (Alnajem et al., 2018). As such, the satisfaction of the employees is often associated with the performance of the employees. As a result, to make the employees satisfied the factor of the physical workplace needs to be applied to all workplaces within the organization (Naharuddin & Sadegi, 2013: Alnajem et al., 2018). All stakeholders have to commit to the relationship to achieve the required level of employee performance. When full commitment is offered, it will lead to a positive result in the performance of the employees.

Correlation between work environment factors and sustainability of outcomes. There was significant evidence to reject $H3_0$ and conclude that there was a strong positive association between work environment factors (Mean = 4.29, SD= 0.60) and sustainability of outcomes (Mean = 3.86, SD= 0.73), $r(49) = 0.330$, $p < 0.05$. This result indicated that the work environment is statistically significantly and has a weak relation associated with the sustainability of outcomes

According to Zhang and Wang (2018), the level of the coefficient determines the strength of the correlation. Generally, only the sustainability and outcome correlation coefficients have a strong positive relationship while the coefficients between work environment factors with the level

of success, outcome and sustainability, level of success coefficients with benefits, and sustainability have a weak positive relationship (Harrington, 2009).

These results reinforce the findings of previous studies. For example, Yadav, Seth, & Desai (2018) affirmed that collaboration and teamwork as robust concepts explain how business leaders define the innovative execution of an integrated Lean Six Sigma framework. Effective training program as well as high level of job satisfaction can improve the LSS succession planning (Stevens, 2008). Bounds (1995) advocated the empowering of employees with increased responsibility will lead them to be more innovative in their roles, as well as cultivating acknowledgment of the need for communication, collaboration, and teamwork. Jie et al. (2014) discussed how work environment factors affects the LSS succeed, as operations, executives and management frontrunners must integrate the Lean Six Sigma technique using a collaborative team effort to advance business operations and task performances to reduce variation and remove waste. Thus, work environment factors can make important contributions that fosters the implementation of LSS projects. Exploratory factor analysis is used to analyze the interrelationships among work environment variables and to explain these variables in terms of their common underlying factors.

Mediation Analysis

Mediation analysis assists in approximating the relationship between an independent variable (X) and the dependent variable (Y) on the inclusion of a mediator variable in the regression model (Hintze, 1988). It also allows examination of the additional effects of the independent variable directly on the dependent variable over and above the effects that go through the mediator variable. In this study, a single mediator model was performed. Fritz, Taylor, and

MacKinnon (2012) acknowledged that mediation is said to exist when the effects of one variable (the antecedent) on the second variable (say outcome) is transmitted through an additional intervening or mediating variable. This suggests that mediation is different from other third variable models, such as moderation analysis, in that it clearly assumes that the variables form a causal chain (Fritz et al., 2012). This implies that variation in the antecedent variable causes an effect on the mediator, consequently causing changes in the consequent. For a single mediator model, the antecedent is labeled X, the mediator, M, and the outcome variable is labeled Y (See Figure 7.5).

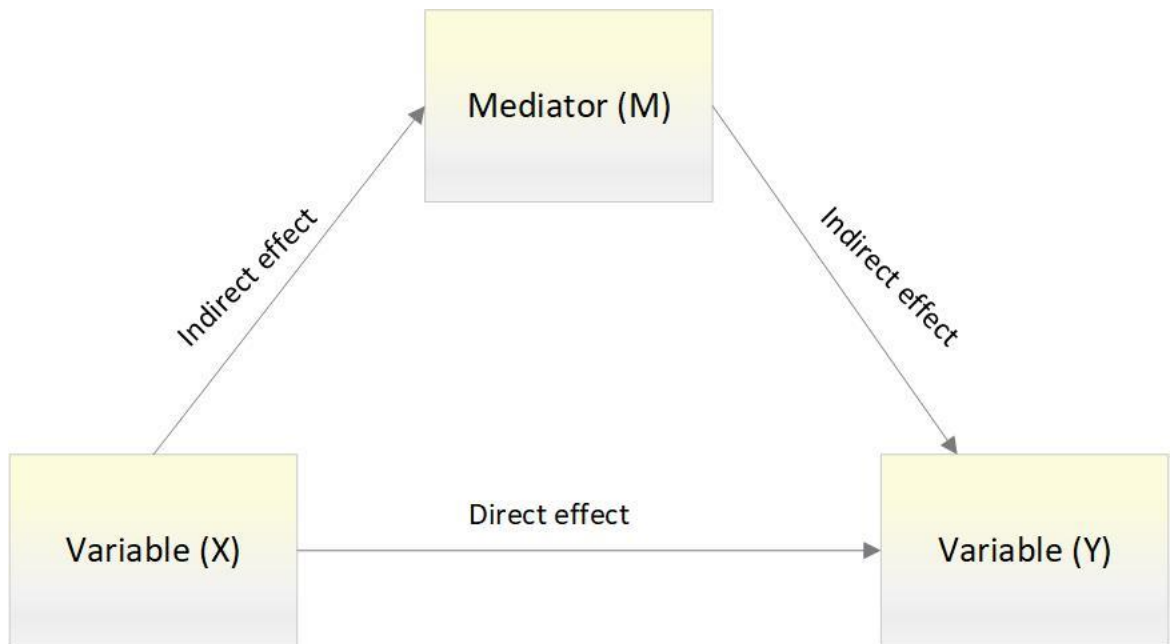


Figure 7.5 Hypothesized Mediation Model

In the mediation analysis, the independent variable was the LSS factors, and the dependent variable was the outcomes. The work environment was the anticipated mediation variable. Before conducting the mediation analysis, the following assumptions were examined;

- Whether the independent variable was significantly related to the dependent variable.
- Whether the independent variable was significantly related to the mediator variable.
- Whether the mediator variable was significantly related to the dependent variables.

The relationship between the independent variable and the dependent variable was first examined. The results revealed that the path (direct effect) from LSS factors to outcomes was positive and statistically significant, $b = 0.641$, $s.e = 0.255$, $p = 0.015$, implying that a unit increase in participants' LSS factors scores was associated with 64.1% increase in the outcomes. The results regarding the relationship between the independent variable and mediator variable showed that the direct effects from LSS factors to work environment factors were positive and significant, $b = 0.863$, $s.e = 0.190$, $p < 0.001$. This implies that for a unit increase in participants' LSS factor scores, there was a corresponding 86.3% increase in their work environment scores. Additionally, for the relationship between mediator variable and the dependent variable, the results indicated that the direct effects from work environment factors to the outcomes were positive and significant, $b = 0.552$, $s.e. = 0.154$, $p < 0.01$, indicating that for a unit increase in participants' work environment scores, there was a corresponding 55.2% increase in the outcomes scores.

However, when a regression model with both the mediator variable and independent variable was performed, the coefficient of the independent variable (LSS factors) reduced and became insignificant, $b = 0.237$, $s.e = 0.284$, $p = 0.402$, whereas the coefficient of the mediator

variable in predicting the outcomes increased and were significant, $b = 0.468$, $s.e = 0.182$, $p = 0.01$ (See Table 7.10). This implies that the work environment fully mediated the relationship between LSS factors and outcomes.

Table 7.10 Coefficients Table for the Multiple Linear Regression

			Estimate	S.E.	C.R.	P	Label
Work environment	<---	LSS factors	.863	.188	4.599	***	par_1
Outcomes	<---	Work environment	.468	.182	2.574	.010	par_2
Outcomes	<---	LSS factors	.237	.284	.837	.402	par_3

Interpretation of the Mediation and Implications

The path (direct effects) from LSS factors to work environment was positive and statistically significant, $b = 0.863$, $s.e = 0.188$, $p < 0.01$. The path (direct effects) from LSS factors to the outcome factors was positive and statistically insignificant, $b = 0.237$, $s.e = 0.284$, $p = 0.402$, indicating that participants' scores on LSS factors are more likely not to affect the outcomes. The direct effects of work environment on outcomes were positive and statistically significant, $b = 0.468$, $s.e. = 0.182$, $p < 0.05$, indicating that participants scoring higher in work environment factors are more likely to have higher effects on outcomes than those scoring lower on the measure (See Figure 7.6 for the relationships between the independent, dependent and mediator variable).

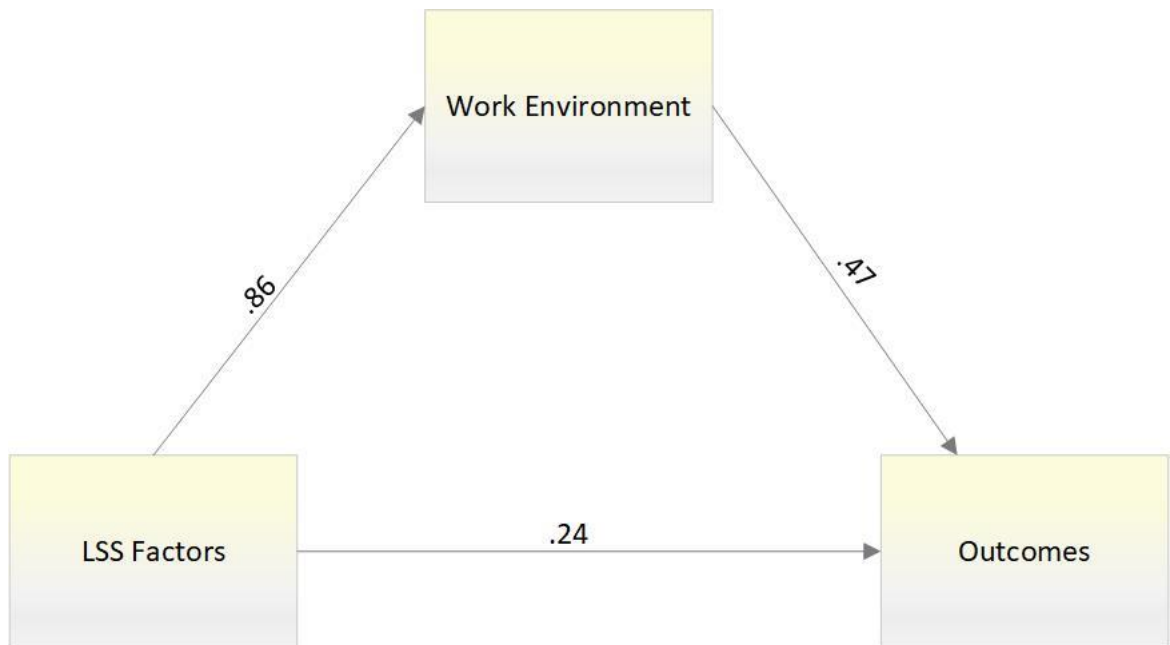


Figure 7.6 Final Mediation Model

The findings revealed that the work environment fully mediated the relationship between LSS factors and outcomes. The path from LSS factors to the outcome factors was positive and statistically insignificant, $b = 0.237$, $s.e = 0.284$, $p = 0.402$, indicating that participants' scores on LSS factors are more likely not to affect the outcomes. Other findings showed that the direct effects of work environment on outcomes was positive and statistically significant, $b = 0.468$, $s.e. = 0.182$, $p < 0.05$, indicating that participants scoring higher in work environment factors are more likely to have higher effects on outcomes than those scoring lower on the measure.

7.6 Discussion

LSS creates a synergy that yields far greater benefits including the following: structured approach to eliminating the root cause of the problem; stakeholder involvement at every stage of the road map; statistical as well as walk-the-floor approach combination; breakthrough and sustainable improvements for customer delight; improves teamwork and involvement; easy to document and share for best practices; cuts across cross-functional barriers; reduces hands-off and improves process flow; reduces both process waste and process variation; and systematic deployment approach (Sunder, 2013). However, assumption is that successful implementation of lean six sigma requires certain conditions in the work environment. The results of the study revealed several aspects regarding the impact of work environment factors in LSS projects in emergency departments to achieve improvements. Based on the results, all work environment factors have a strong relationship with successful LSS projects. The findings of EFA and CFA could lean to the conclusion that teamwork, communication, and job satisfaction are well recognized in the implementation of LSS in EDs.

Staff motivation is considered essential to the successful implementation of LSS. Motivation refers to the force that moves individuals. According to experts and practitioners in the field, work motivation is a multidimensional concept associated to how employees interact with, and perceives their organizations and is reflected in the degree to which employees feel a sense of connection, obligation, and reward in working for an organization (Moynihan & Pandey, 2007). Furthermore, work motivation has been referred to as a set of energetic forces that originate from within an individual, which are instrumental in initiating work-related behaviors (Latham & Pinder

2005). In the implementation of LSS, staff motivation may be considered vital especially when noting the significant change in work practices associated to the adoption of the new concept in the workplace. Belief is that motivated staffs are most likely to support new initiatives that could enhance organizational performance. Furthermore, motivated staffs are also expected to be more committed to their jobs and would therefore be more tolerable of improvement projects such as the introduction of LSS to the organization.

Closely related to work motivation is job satisfaction. Job satisfaction has been viewed as an integral construct in organizational psychology, given that it is associated with several other important work-related and general outcomes including job performance, organizational commitment, discretionary activities such as organizational citizenship behavior and life satisfaction as well as with absenteeism, lateness, and turnover (Cohrs, Abele & Dette, 2006). Job satisfaction has been referred to as positive affect of employees towards their jobs or job situations (Davis, 2004). In Ghazzawi and Smith (2009), job satisfaction has been described as an individual's positive or negative attitude toward his or her job. Similar to staff motivation, job satisfaction has been identified as a vital requirement for the successful implementation of LSS. Staffs who exhibited high levels of job satisfaction would be more open to projects and initiatives that could improve organizational performance. As previously noted, job satisfaction has been associated to organizational commitment and citizenship among staffs.

Employee training has been described as the planned effort of an organization to ensure that employees learn all the necessary job-related competencies, primarily all the knowledge, skills, or behavior that are vital for the effective performance of the job (Noe and Winkler, 2009). Majority of organizations today have a definite policy for employee training with the long-term

goal of attaining enhanced level of organizational effectiveness (Jain and Agrawal, 2005). In practice, organizations rely on training to cascade new knowledge and technologies. For instance, organizations attempting to introduce new concepts and programs in the workplace tend to conduct training sessions to introduce the new concept to the members of the organization (Acton & Golden, 2003). The introduction of LSS to the organization would not be possible if training has not been instituted. As noted in Thomas et al (2014), an effective education and training system facilitates successful implementation of LSS. Training would ensure that staffs are equipped with the required knowledge and skills to adopt the new concept. The staffs who have undergone extensive training in LSS are called Black Belts who lead in continuous improvement projects and are also responsible in coaching the Green Belts within their assigned units (Park, 2005). Training for Black Belts ranged from 4.5 to 7 weeks, typically in the form of classroom training (O'Rourke, 2005).

Teamwork must also be present in order to successfully implement LSS in the workplace. Teams are gaining importance both in the workplace, expected to improve productivity, creativity, employee involvement, and job security. These have been made possible by the following: First, teams increase information and knowledge by combining the expertise and experiences of members of the team. Second, teams ensure diversity of views which could bring a variety of perspectives and in the process come up with more creative ideas. Third, teams lead to increased acceptance of a solution to the extent that those who participate in making decision are expected to support it and at the same time encourage others to accept it. Last, teams will lead to higher performance level resulting from synergy and effective collaboration among members of the team (Miller, 2003). In the implementation of LSS, highly functional teamwork has been identified as a

critical contextual factor necessary for project success (Abraham, Pepper & Sloan, 2018). In the case of companies that implemented LSS, several teams who were led by Champions were formed to lead the change efforts and transition and to undertake continuous improvement projects (O'Rourke, 2005). Consequently, teamwork is important for the teams to function effectively.

The proper functioning of organizations largely depends on the ability of the members of the organization to communicate effectively with each other. Communication refers to the transmission of information and meaning from one individual to another (Long & Vaughan, 2007), in the aim of achieving a common understanding (George & Jones, 2005). Furthermore, communication refers to the methods by which the organization's awareness of new initiatives is articulated (O'Rourke, 2005). Particularly in implementing new concepts and work practices, communication plays a crucial role in informing and gaining the support of the employees. According to Laureani & Antony (2012), organizational communication has been identified as one of the critical success factors in the implementation of LSS. Based on the experiences of many organizations, a good communication plan could contribute largely to the successful implementation of LSS (Stankalla, Koval & Chromjakova, 2018). In the case of a manufacturing firm, good communication across the organization has been considered the key to the success of continuous improvement activities including LSS (Park, 2005). In addition, the successful implementation of LSS also requires the leader to communicate a clear and concise lean six sigma vision. (Knapp, 2015).

Employee engagement reflects the extent to which an employee puts discretionary effort into his or her work, beyond the required minimum to get the job done, in the form of extra time, brainpower or energy (Devi, 2009). As such, employee engagement has been linked to several

organizational outcomes like productivity, profitability, employee retention, safety, and customer satisfaction (Little and Little, 2006). With regards to the implementation of LSS, employee engagement may be considered vital to the successful implementation. Primary belief is that highly engaged employees are less likely to resist improvement efforts. Furthermore, highly engaged employees are expected to have favorable attitudes towards initiatives that will enhance organizational performance.

7.7 Conclusion, Limitation, and Future Work

Different analyses have been conducted in this study to investigate the impact of elements of work environment internal to the emergency department such as staff motivation, job satisfaction, training practices, teamwork, communication, and engagement and collaboration, which have been considered vital to the successful implementation of LSS. Staff who demonstrate high levels of motivation, job satisfaction and engagement are expected to have favorable attitudes towards the implementation of improvement efforts such as the LSS. Meanwhile, training and communication act as enablers that facilitate the smooth implementation of LSS. Finally, effective teamwork would ensure proper functioning of teams during the implementation process.

The main limitation of this study is in the small sample size with a relatively low response rate of 21.3%. In addition, the sample of the responding administrative and medical professionals were small with a response rates 14.3 and 18.4%, respectively. This research could be strengthened by exploring whether different opinions exist among administrative professional, medical professionals, and academic researchers with regard to successful factors of LSS projects. Although this is acceptable for an expert study, future studies should have broader quality

healthcare experts and medical professionals and gather more responses for analysis. However, the findings and results obtained from this research are valuable for quality practitioners as well as medical and administrative professionals as a guideline to achieve the successful implementation of LSS implementation.

This study is an exploratory study and the primary goal was to develop a construct for the elements of the WE as well as to create some exploratory quantitative models of LSS success in ED given the work environment context. Therefore, future work should the sample of experts and utilize multi-item constructs such as those that were developed summarized in Appendix E, to focus on developing the CSFs construct of LSS implementation using a wider survey in order to get larger sample size and develop stronger statistical models.

7.8 References

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CHAPTER 8: DISCUSSION AND RESULTS

In the previous chapters the results developed from the various phases were summarized in an attempt to answer the core research questions set for the study. First, a comprehensive literature review was performed to investigate the evidence related to use of continuous improvement tools in emergency departments. In this discussion chapter, the results of the study and the literature review are compared and contrasted. This helps in determining areas of literature that the findings from this study support, as well as areas in literature that findings from this study disagree with. By comparing the results to literature, it also offers insight into the interpretation of the results and evidence available in the literature. The discussion also identifies gaps that exist in literature concerning the impact of work environment on successful implementation of LSS in emergency department. The gaps will be identified based on aspects of the findings that will be found not to exist currently in the body of research. The final section of this chapter presents practical implications of the findings whereby recommendations and suggestions are offered with regards to steps and approaches that emergency departments should take in implementing LSS.

8.1 Critical Success Factors of Lean Six Sigma

LSS combines two independent methodologies, the Lean and Six Sigma. The Lean method offers a step-by-step procedure to reduce and eliminate operations that do not make a process valuable. Six Sigma is a problem-solving technique that is driven by data (Lande et al., 2016). Therefore, the LSS approach defines an evidence-based and data-driven method of improving a service based on the ability to detect errors instead of preventing mistakes. The study has identified

some factors critical to the successful implementation of the LSS in emergency departments. This research consisted of a mixed-methods, empirical study starting with the a comprehensive review of the literature (Chapter 4) to investigate recent advancements in CI in ED followed by a Content Analysis study to inductively synthesize available evidence as well as guiding the development of an LSS implementation framework for ED settings. A Content Analysis (Chapter 5) was conducted to review the literature to identify the critical success factors of LSS in EDs. The study's findings include; management commitment, organizational culture, and LSS knowledge (Alhuraish et al., 2017). Others include data availability, linking LSS to customers, and organizational structure. In addition to the above include a communication plan, training program, staff collaboration, and time (Fairul et al., 2015). The Content Analysis highlighted management commitment, organizational culture, and linking LSS to business strategy as critical success factors. Other factors from the review included project selection and prioritization, communication plan, training program, organizational structure, LSS tools and techniques, and project management skills. (Viljoen et al., 2018). As a methodology, LSS tries to remove waste from the emergency department's operations. The removal of waste exposes conditions which are necessary and whose exploitation will lead to achieving the organizational objectives.

Round 1 of the Expert Study and Grounded Theory (Chapter 6) were conducted to investigate and identify the importance of the CSFs and their interrelationships. The results returned management commitment and organizational cultural as the two most important critical success factors to LSS success. The findings are similar to several earlier studies (Ahmed et al., 2018; Laureani and Antony, 2012; Snee, 2010; Zhang et al, 2016), all of which placed “management commitment” as the most important CSF. When there is direct participation by top

managers in all aspects of the emergency department, the chances of success increase dramatically (Zhang et al., 2016). Given a supportive organizational culture within the emergency department, the workforce will adhere to initiatives rather than deviate from the expected norm. The staff is also expected to be well equipped with knowledge associated with the LSS (Alhuraish et al., 2017). This will enable them to identify and eliminate the weakest spots in the emergency department. The Six Sigma methodology is data-driven. Therefore, the presence of data will help the top managers of the emergency department to make decisive decisions (Alhuraish et al., 2017).

In contrast to the earlier results, the Expert Study survey (Phase 3) discovered four vital areas which were not captured in the Content Analysis. First, is LSS knowledge as it would be practically impossible to implement a model with which is the team has little or no knowledge (Hilton et al., 2008). Therefore, understanding how LSS should be executed and its requirements is a critical factor for the emergency department staff (Zhang et al., 2016). Also, the availability of data is another area that is distinct from the listings of the literature study. This is because LSS is a data-driven approach. Without data, the emergency department cannot identify the areas that need to be eliminated or improved (Laureani & Antony, 2012). Staff collaboration was the third critical factor identified in the Expert Study survey that was not part of the Content Analysis. The collaborative effort of the entire staff will ensure that there is teamwork to aid the achievement of organizational goals (Manville et al., 2012). Finally, the last critical factor identified in the survey was the project timeline. In the emergency department, time is one of the most valuable assets and determiner of their success (Laureani & Antony, 2012). Therefore, the adherence to time in work delivery will ensure the smooth implementation of the LSS.

Round 2 of the Expert Study (Phase 4) confirmed that management commitment was the most important CSF in the emergency department, as confirmed by the empirical evidence from the survey. It is believed in theory and the practical world that the direct involvement of the various departmental heads, unit heads, and all other top managers in the emergency department will ensure that LSS is implemented successfully to achieve and sustain improvements. Management commitment was clearly rated as the most important across all sources. There is agreement about this factor, and it was found that experts reported this factor was being addressed in their studies, which were associated with high levels of success.

8.2 Successful Implementation of Lean Six Sigma in Emergency Departments

The findings for Round 1 of the Expert Study and grounded theory (Chapter 6) were used to develop the theoretical model of successful implementation of LSS in emergency department (Figure 9.1). The theoretical model consisted of components or elements that should be contained in any implementation process for LSS in the emergency department.

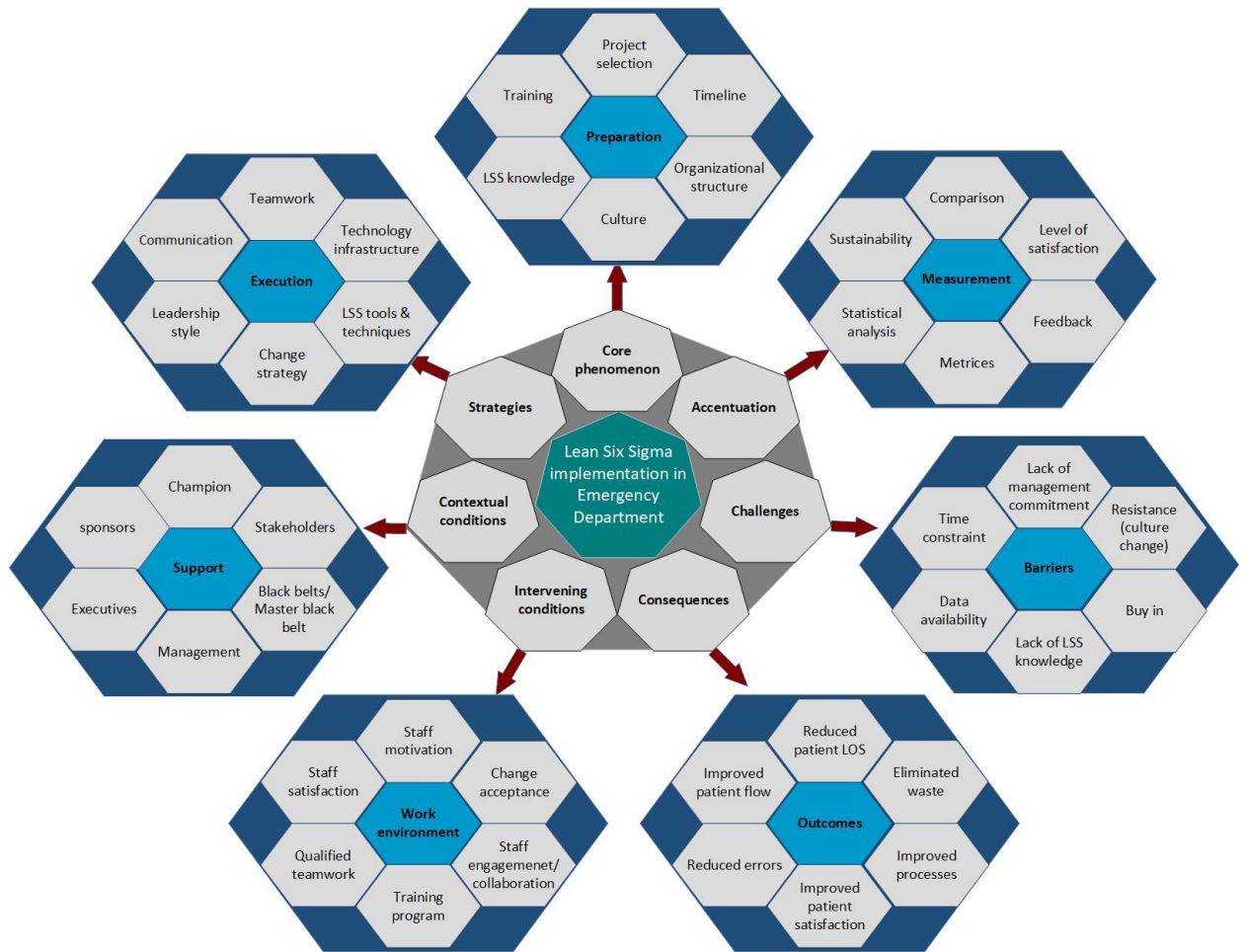


Figure 8.1 Theoretical Model of LSS implementation in EDs.

The model identified seven major categories of successful implementation of LSS including preparation, execution, support, work environment, outcomes, barriers, and measurement. The multiplicity of the categories shows that the implementation of LSS in emergency department is a multifaceted and multivariate process that involves many different factors. The following sub-sections provide a discussion of the seven categories with specific emphasis on their application in the emergency department.

Preparation

From Round 1 of the Expert Study results, it was found that the preparation category of LSS implementation in the emergency department setting involves six main sub-categories which are project selection, timeline, project alignment, culture, LSS knowledge, and training. The variety of aspects that form preparation implies the need for leaders in the healthcare setting, particularly those in emergency departments, to place importance on the overall planning for the utilization of LSS for any form of project implementation. This is a position that is strongly supported in the body of literature as Al Khamisi et al., (2017) noted that LSS is a practical model or tool that requires adequate preparation on the part of all stakeholders to know the specific roles they can play in making it successful within the organizational context. The fact that the results identified the need for undertaking training and inculcating LSS knowledge shows an appreciation for the role of all stakeholders particularly employees (Zhang et al., 2016. Also, Henrique and Godinho Filho (2020) underscored the fact that part of the preparation must focus on the core needs of the organization that the tool seeks to solve as well as the work processes that it attempts to improve. It is against this background that the main aspects of preparation as identified from the results make specific reference to project alignment and culture, which confirms the relationship between LSS implementation and existing work processes within the emergency department.

Execution

The second category is execution, which refers to the stage of the LSS implementation where the actual model is rolled out or executed. From the results, six main sub-categories that

must be considered during the execution include teams, technology infrastructure/data, LSS tools and techniques, change strategy, leadership style, and communication. From every indication, these components are very comprehensive and exemplify that the successful execution of any LSS project must consider almost every possible and potential input that include human resource, organizational culture, workplace processes, and logistics (Freitas & Costa, 2017). Emphasizing on the components of communication and data, Bal et al., (2017) noted that the modern emergency department is highly sophisticated and deeply dependent on technological advancements that aim to eliminate the manual processes of work, which are often associated with waste and errors. Technology is therefore an important requirement to achieve lean by eliminating waste (Jeyaraman & Teo, 2010). Meanwhile, for the technologies to function effectively, it is important to have the right infrastructure and data based on which it would operate (Neuenschwander et al., 2016). Such data must also be communicated effectively to avoid miscommunication that results in wrong execution of processes (Bal et al., 2017). Relating this to the other components, the results have showed that there must be the right teams and leaders in place, as well as the right change strategy, tools and techniques if the technological aspects can function effectively.

Support

The next category identified from the results is support, which entails components like champion, stakeholders, master black belts, black belts, management executives, and sponsors. Generally, these components represent the areas and levels of expertise and competence required to make the LSS implementation successful (Chugani et al., 2017). One significant feature of the support constituent is that it appreciates the need to have multiple players each playing their role expertly to ensure the successful implementation of the model (Hilton et al., 2008). The fact that

the players include sponsors and stakeholders means that the support does not only have to come from the internal work environment but external also. This aspect of the findings is a major gap that the study filled from the body of literature, given that most available works of research only identify the role of internal stakeholder particularly leaders and their employees in the implementation of lean (Albliwi et al., 2017). The results of this study have however showed that the role of both internal and external stakeholders is necessary if the implementation will work as expected. Specific to the emergency department (Jeyaraman & Teo, 2010). Ruben et al., (2017) appreciated that its running must fall in line with globally accepted benchmarks and practices. It is against this backdrop that the involvement of external stakeholders is necessary in setting standards that are not only within the expectations of internal stakeholders but also those outside the organization (Albliwi et al., 2017).

Work Environment

The results also identified the place of the environment as a specific constituent of LSS implementation. Under this, the category of work environment necessary for successful implementation was found to include self-motivation, change acceptance, staff engagement/collaboration, training program, qualified teamwork, and self-satisfaction. In essence, this category shows the nature of environment necessary at the workplace to make the implementation feasible (Laureani & Antony, 2012). A careful assessment of the requirements within the work environment show they focus on the organizational culture, human resource, and human resource management. As far as the emergency department is concerned, available literature supports the need to put all such measures in place in creating the right work environment, given that the inputs that goes into service delivery there is always delicate, complex

and complicated (Laureani & Antony, 2018). Without the right organizational culture that accommodates LSS, it will be difficult for employees to accept changes from what has become regular practice or norm at the emergency department (Marzagão & Carvalho, 2016). Similarly, Mosadeghrad and Woldemichael (2017) posited that without the human resource put in the right frame of mind, it become challenging for them to accept their abilities to make the LSS successful. Meanwhile, the findings highlighted the fact that when the human resource is well-managed by providing the right form of training and leadership, they will not be overwhelmed by the implementation of lean at the emergency department.

Outcomes

The outcomes from LSS implementation refers to the things that leaders of the emergency department desire to achieve for which they utilize the tool. From the results, the theoretical model pointed to six such outcomes or results, which include reduced patient length of stay, eliminated waste, improved processes, improved patient satisfaction, reduced errors, and improved patient flow. The nature of the outcomes ad results show that LSS is implemented largely with the ultimate goal of improving healthcare delivery at the emergency department (Hussain, 2018). Several studies in the body of literature support the findings that show the role of LSS implementation in healthcare delivery. For example, Lande, Shrivastava and Seth (2016) underscored the fact that LSS improves healthcare delivery by fostering a culture of efficiency associated with the reduction of waste and maximization of employee potential. What is more, Laureani and Antony (2017) acknowledged that LSS improved healthcare delivery because its focus on using the best available resources including human resources ensures there is a guarantee of quality output of work. An important trend with the outcomes and results from the findings is that the benefits can be traced

from both employees and patients because for employees, it ensures they minimize errors, which sometimes have legal implications for them. On the part of patients, lean guarantees service satisfaction for them (Hilton et al, 2008; Ahmed et al., 2018; Mishra, 2018).

The sub-category of barrier was linked with six main categories in the results of the study. The six are lack of management commitment, resistance to culture of change, buy in, lack of LSS knowledge, data availability, and time constraint. All these six are specific challenges and barriers that confront and fight against the successful implementation of Lean at the emergency department. A careful consideration of the barriers show they are multifaceted as they include challenges relating to the organization as a whole, management, resources, and employee (Yadav & Desai, 2016). In effect, the barriers are all within the work environment and thus spell the need for leaders utilizing the LSS to concentrate on creating the right work environment at the emergency department (Yadav & Desai, 2016). Improta et al. (2019) strongly supported this position as they mentioned that the work environment is the nursery that nurtures the LSS. It is thus important that the nursery will be very fertile to ensure continuity and growth. Holmberg, Sobis and Carlström (2016) also cautioned on the need for leaders to have prior knowledge of the possible consequence of some of these barriers and attempt to prevent them from manifesting. This position was supported by the findings of the study as it showed that a risk management practice can help to mitigate most of the barriers to LSS.

Measurements

The final six sub-categories that comprise the measurement constituent of LSS implementation in the emergency department were identified from the theoretical model that was

developed under the results section. The six sub-categories are comparison, level of satisfaction, feedback, metrics, statistical analysis, and sustainability. These six aspects of give a general indication of the practices, inputs and outcomes that healthcare leaders implementing LSS use to measure the extent to which their goals have been achieved. From the body of literature, Honda et al. (2018) agrees to the need to make measurement a central part of LSS implementation. The need for measurement stems from the fact that it helps the leaders to stick within a specific scope of delivery that fits into the specific needs of the emergency department (Honda et al., 2018). From the findings, it was found that the complex nature of LSS can cause tendency of going outside the scope of needs for the organization and thus the need to have a measurement that help to keep implementers in check (Freitas & Costa, 2017). A measure gap that the results from the study fills from the body of literature is the impact of LSS measurement on sustainability (Freitas & Costa, 2017). The more the leaders measure the inputs and outputs, the greater their chances of continuing the implementation of LSS even for other leaders that come after them (Honda et al., 2018).

8.3 Impact of Work Environment

This study conducted a questionnaire survey (Round 2 of the Expert Study) to investigate the impact of elements of work environment on LSS implementation in the emergency department. The study discovered teamwork, communication, job satisfaction, staff training, staff motivation, and staff engagement and collaboration as the six main elements of work environment. Each of the six elements will be discussed by identifying their implications to the LSS in the emergency department. Various scholarly works related to the discovered workplace factors' implications in the emergency department will be reviewed in addition to the study results of the study

The findings of the study indicate that teamwork is one of the most significant work environment factors that influence the implementation of LSS. Teamwork ensures that there is togetherness in the workplace, and all the workforce work towards the achievement of the emergency department's organizational goal. Teamwork ensures that all units in the emergency department do not work in isolation. A scholarly work indicates that when various groups and management in the emergency department involve themselves and play active roles in achieving the organizational goal, it leads to a boost in the team's morale. Through this effort, the real sense of teamwork is brought to life since there is no division. Though, there is a division of labor, yet, each one's contribution is significant and equally rated (SixSigma, 2018). Another study concludes that teamwork's impact on the LSS implementation leads to the development of vibrant leadership, clearly defined organizational goals, clearly stipulated division of labor, commitment, productive meetings, and action plans. Teamwork was described as the key to ensuring that everyone becomes fully engaged in waste elimination, improvement of quality service, and bridging the innovation gap (Staff, 2017). There is a correlation in the outcome of the survey to what other researchers have discovered in the role of teamwork in the implementation of LSS in the emergency department. Though different views were expressed in the literature, they all complement them and add to the value of teamwork in eliminating waste and increasing work efficiency in the emergency department.

The study's findings discovered communication as the second work environment factor that influences the implementation of LSS in the emergency department. In the absence of communication, it will not be possible for the emergency department to successfully get the expected outcome from the implementation of the LSS. There should be communication among

team leaders and the entire workforce of the emergency department to identify operations that can be considered as waste. Hill et al. (2020) made it clear that the implementation of the LSS methodology places excellent communication among the entire workforce as a requirement. Through communication, employees at various departments and units can voice their concerns and seek redress by the management. Pexton (2020) asserted that the implementation of LSS leads to behavioral changes. Therefore, it is vital to develop a carefully crafted communication plan to discover and address human-related challenges. Team leaders must thus communicate the organization's vision and strategies to stakeholders to entice dialogues. There is a need for a platform that enables conversations among stakeholders in an organization to identify areas in the business operations that needs attention. The failure to implement the communication plan will create room for cynicism, rumors, and speculations. The two scholarly works confirm the study's findings in terms of the impact of communication in the implementation of LSS in the emergency department. It remains an indisputable fact that, without a properly structured communication plan, the organization cannot identify gaps to be filled.

The study found job satisfaction as a work environment factor that impacts the implementation of LSS in the emergency department. Discovery of job satisfaction is essential in identifying areas that need to be discarded and others that need enhancement. The findings of the study indicate that views of the employees and customers relating to job satisfaction can be identified through the implementation of the LSS in the emergency department. Rivera (2019) postulates that job satisfaction influences LSS to the extent that managers can improve production quality, and reduce cost and waste. Rivera sees job satisfaction in the context of employee development through skill training. The researcher believes that job satisfaction depends on how

skillful the employees are; therefore, appropriate analytical skills and understanding of concepts should be provided to them. In another study, employees' involvement in six sigma brings about a feeling of positive changes in terms of job satisfaction. Perceived changes from the study were related to the development of new skills and the impact on work duties (Singh, 2020). The scholarly works have job satisfaction, depending on the employees' skills. To them, the ability of the workforce in terms of expertise can increase productivity or create a cost for the organization. This can be revealed through the implementation of the LSS. Comparatively, findings of the survey do not correlate with the scholarly works. The study identified areas to be discarded through the employee's and customer's level of job satisfaction when the LSS is implemented in the emergency department while the literature's concentration was on employee's skill acquisition.

The findings of the study indicate that staff training is another work environment factors that imply the implementation of LSS. When the staff is adequately trained and enhanced with the required skill to deliver the set target, it will quickly identify areas that need development. On the contrary, it will be challenging to identify areas that need changes when the staff lacks the required orientation. Research has established that not all employees of an organization are assets and game-changers. Though such incompetent staff may qualify on paper, on the practical side, they may be liabilities to the organization. Some employees may be busily moving up and down, but in reality, they may not add value to the organization (Paulise, 2019a). Productivity and profit can be maximized in a work environment where LSS is implemented under the condition that the staff is trained. An organization can reap benefits from six sigma when a significant number of its staff are trained and have acquired cutting-edge skills. An increase in the number of professionals in an organization will reduce wastes and promote problem-solving skills (Villanova University, 2020).

The two literature reviews in this context correlate with the research findings. It is evident that when the staff of the emergency department is highly trained, the turnout of organizational performance will be comparatively higher than a team that lacks adequate skills. The ability of the skilled staff will unveil areas that need adjustments and removal to ensure maximum work efficiency.

Implementing the LSS is highly effective in a work environment where the staff is well motivated in the emergency department. The motivation could be better conditions of service, including compensations, annual salary bonuses, and a conducive working environment. The study revealed that a poorly motivated staff leaves room for ineffective and unproductive work output. According to Paulice (2019b), millennials respond to work environments with autonomy, feedback, inspiration, and flexibility. Any working environment that is deficient in the parameters listed serves unfruitful for them. They are not productive in environments that are traditionally managed. The workforce of an organization remains committed to their job when they develop an interest to the millennials, the LSS in their natural environment, and useful for them. Six Sigma Daily (2019) affirms that employees at Toyota have the autonomy to abort an operation upon the detection of a challenge. The company offers first-hand access to its leaders to interact with frontline operations and demand input from employees. The provision of these privileges provides the staff with a sense of belonging, involvement, and worthy of inclusions and submissions. The two literary works are in line with the findings of the study. Motivation is a crucial factor in the implementation of LSS. In the absence of a motivated staff, several wastes and lack of productivity are liable to flood the emergency department. The findings of the study affirm what others have discovered concerning the motivation of staff in the work environment.

The study findings indicate that staff engagement and collaboration are among the work environment factors that influence the implementation of LSS. An organization that imposes and dictates to its employees without considering their views and sentiments can develop waste at their blind spots. The lack of cooperation and staff engagement will serve as a barrier for the staff to interact with the top managers freely and reveal leakages. Dyer (2016) argues that an organizational culture whose foundation is laid on fear compels the employees to interpret instructions as gestures when deciding the leaders' expectations. Dyer compared the lack of staff engagement and collaboration to the spread of cancer, which causes damage to its host. In such an organization, waste of resources can remain undetected for an extended period. By nature, employees have exhibit fear in their management.

For this reason, the earlier the leaders wipe out the fear, the better will it be. In an article published by the Graham Local School (2020), LSS relies on collaborative teams to overcome challenging situations and implement lasting solutions. Organizations that work on collaborative teams succeed quickly in competitive environments. It is clear from the two literature works that staff engagement and collaboration, as discovered by the findings of this study, is a great determiner and on the successful implementation of the LSS. An organization that is void; this quality stands the chance of creating so many wastes and undetected changes that will ruin their integrity. The emergency department is expected to take note of this quality to develop it to the fullest when implementing the LSS to become active, efficient, and productive while cutting waste.

The Mediating Effect of Work Environment

With the work environment fully mediating the relationship between LSS factors and success outcomes, the results of this study suggest that it plays a significant role in successful use of LSS in the emergency department. The work environment emphasizes the important role that employees play in completing meaningful work and achieving positive results (Aiyadh et al., 2014). This mediating role of a work environment also shows that when employees observed that the emergency department values and appreciates their contributions, they tend to respond reciprocally by showing a cooperative behavior (Osborne & Hammoud, 2017).

When employees are found to be positively providing teamwork and effective communication, it evidently results in recognizing a positive cycle of work environment. Further, it demonstrates whether employees are confident in themselves and in their daily work duties, which are essential for an organization to effectively integrate a change or institute quality within the workplace (Pastor, 2013). When employees are recognized, they become positively competent and, therefore, create a sense of ownership of the outcomes within their workplace, signifying the existence or possibility of a higher quality of management and performance (Abner, 2016). The impact of consistent engagement of both the management and employees' results into developing a healthy work environment, which then results, accordingly, in engaged employees show an increased quality of work and possibility of a more positive effect if change is integrated (Swarnalatha & Prasanna, 2018).

Work Environment and Organizational Culture/Climate

Organizational culture is usually defined as the symbolic and physical personality instigated inside every organization (Tedla, 2016). It can also be perceived to involve the norms that the people of an organization experience and define as their work settings. These norms are the ones that mold how the people behave and adapt to attain the results in the organization (Mohammad, 2017; Morcos, 2018). In view of this, it is important to understand how organizational culture involves how the people of an organization interact with each other and with the other stakeholders. When researchers study how an organization functions, its culture is generally important as it reveals a set of beliefs, values, and behavior patterns that will differentiate that organization from other organizations (Tedla, 2016). Overall, the organizational culture provides an overall picture of how an organization can provide a psychologically safe workplace for its employees in order for it to perform effectively (Tedla, 2016).

On the other hand, work environment is specifically defined in this study to measure how employees experience work in an organization including effective teamwork, communication, and engagement as well as measures of experience such as job satisfaction, staff motivation, and perspectives of staff training. In a sense, work environment can be observed to be related to but conceptually distinct from organizational culture (Mohammad, 2017).

8.4 Summary

This chapter was used to present a discussion of the key findings from the study. The discussion gave a detailed interpretation of the results and how they apply to the emergency department. The discussion also involved an evaluation of the study's findings in relation to available literature on the subject of work environment and its impact of LSS at the emergency department. The chapter was structured into three main themes or sections. From the first theme, it has been established that there are numerous critical success factors that impact on the implementation and outcome of LSS. While the ranking of factors from the results and body of literature are different, the similarity in the factors alone is enough evidence to suggest that leaders who want to succeed with LSS cannot ignore the factors. Similar results were found under the third theme where six different work environment factors were found to impact on the implementation of lean and thus the need to always give each of them adequate attention. From the second theme, it emerged that the actual practice of implementation of LSS is a multifaceted process that includes several constituents including preparation, measurement, barriers, outcomes/results, work environment, support, and execution. Leaders must master all these constituents if they can achieve their targeted goal for implementing LSS.

8.5 References

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CHAPTER 9: CONCLUSION AND FUTURE WORKS

Nowadays, healthcare organizations are facing challenges implementing process and continuous improvement tools and techniques to improve the productivity and quality of the provided care services. LSS is one such approach and it combines the strategies of Lean to eliminate waste with Six Sigma, which focuses on variation in process. Therefore, the principle of LSS helps to improve the efficiency and quality of the processes. LSS is one of the most used models in industrial and business areas and rapidly spreading throughout the healthcare industry too. Many healthcare organizations have implemented a Lean Six Sigma (LSS) approach successfully, and achieved excellent outcomes and benefits, such as improve productivity, reduce costs, and improve patient satisfaction (Hilton et al., 2008; Laureani & Antony, 2012; Mandahawi, 2018). Despite the effective implementation of LSS in emergency departments, in particular, some healthcare organizations have concerns about the implementation process as well as concerns of change in organizational culture and failure to recognize the need for change as it could put a great burden on them.

The objective of this research is to develop a theoretical model of the factors for successful LSS implementation in ED including the impact of work environment on successful implementation of LSS. In addition to the conclusions summarized in each chapter, there are five key insights that should be noted.

The first insight was based on conducting the systematic literature review to evaluate peer-reviewed journals that are relevant to the research area – the use of quality process improvement tools in emergency departments. The results concluded that most of the works on improving the

ED implement Lean approach (23 publications), while there was regular use of implementing LSS (13 publications). Only four publications adopted Six Sigma to address different issues in ED, such as patient length of stay. Existing evidence in the literature show that many researchers have studied LSS in manufacturing and service industries and the results of those studies show a vast amount of improvement in the systems. On the other hand, the use of LSS in ED is very limited; 33% papers studied such approach in the emergency department. In that regard, the review supported the development of the conceptual framework of successful implementation of LSS in ED.

The second insight was based on identifying the most critical success factors of LSS implementation in emergency department using the Content Analysis and the two rounds of expert study. The findings of the research presented the most critical success factors of LSS implementation in emergency department based on the Content Analysis and most critical success factors of LSS implementation based in emergency department based on the Expert Study survey (Phase 3). On the bases of Content Analysis, the result showed management commitment, organizational culture, linking LSS to business strategy, linking LSS to customers, project selection and prioritization, communication plan training program, organizational structure, LSS tool and techniques and project management skills as the most critical success factors of LSS implementation in emergency department. On the basis of the Expert Study survey (Phase 3), the grounded theory approach as a qualitative research based on survey questionnaire with quality practitioners' experts. The data was analyzed and a theoretical framework of LSS implementation in emergency departments was developed. The theoretical model involves all aspects that impact the LSS: preparation, execution, support, work environment, outcomes, barriers, and

measurements. The results showed LSS knowledge, data availability, staff collaboration and time as an addition to the most critical success factors of LSS implementation in emergency department. This can be concluded that companies willing to ensure quality work environment by adopting LSS should take into consideration all necessary measures needed to eliminate difficulties associated with the implementation of LSS and reinforce the critical success factors.

The third insight was identifying how emergency department work environment factors affect LSS implementation success by focusing on the strength of association between work environment factors and the successful LSS project, the strength of association between work environment factors and the achievement of outcomes of LSS and the strength of association between work environment factors and the sustainability of outcomes. These were investigated by conducting Bivariate analysis and developing regression models. The results showed that, while the CSFs did have a statistically significant relationship with the outcome variables, WE was also found to have statistically significant relationships with both the CSFs and the outcome variables.

The fourth insight was focused on identifying the underlying dimensions of work environment. Exploratory factors analysis was conducted to identify the underlying latent constructs of work environment. The results showed that all six identified elements of work environment loaded to a single factor creating a six-item Likert-scale construct for assessing the strength of the WE.

Finally, the fifth insight is in regard to the mediating effect of work environment. The Mediation analysis results showed that work environment acts as a full mediator in the relationship between the known CSFs and the outcome variables (i.e., general success, achievement of

outcomes, sustainment of outcomes). This result suggests that addressing the most important CSFs may not be sufficient for ensuring LSS implementation success in the ED. The qualitative and quantitative empirical results suggest that addressing the most important CSFs for LSS implementation is associated with success in the ED despite the strength or quality of the work environment. However, when the WE can act as a key driver amplifying efforts during LSS projects when addressed appropriately.

The results suggest that the implementation of the LSS in emergency department will support continuous improvement in outcomes such as the flow of patients from the emergency department. Thus, the implementation of the LSS can reduce the length of stay in the emergency department. y, A strong internal work environment can be created for the successful implementation of the LSS by enhancing the positive impact of the critical success factors. While these are expected outcomes, the results of this research demonstrate that the successful implementation of LSS at the emergency department is directly influenced by the nature of work environment in ED. In effect, leaders in the healthcare sector and those in emergency departments in particular cannot aspire for the outcomes of LSS, which include improvement of patient satisfaction and safety, without first putting in place the right work environment dynamics and variables that will offset the implementation process. Once the WE has been addressed, traditional CSFs, such as management commitment and organizational culture, can be focused on to ensure success.

9.1 Summary of Contributions to Research

Similar to business organizations, healthcare organizations are also exerting efforts to adopt LSS. In the aim of maintaining competitiveness and effectiveness under increasingly harsh operating environments, healthcare organizations have ventured into growing internal organic continuous improvement programs centered on LSS (Bedgood, 2017). Many healthcare organizations have applied LSS techniques and approaches in various functional areas including admission, discharge, medication administration, operating room, cardiac department, and intensive and critical care (Liberatore, 2013). This dissertation evaluates the effects of WE the implementation of LSS on the emergency department given the currently accepted model of CSFs as documented in the literature and expert experience. The goal of the dissertations is to contribute to the current understanding of LSS implementation success by defining, operationalizing, and quantitatively assessing the impact of work environment in this context to contribute to the development of current theories of LSS success.

The specific contributions described in the previous section center on the inductive development of conceptual and theoretical models grounded in published evidence and expert experience. This dissertation produced four primary frameworks that provide insights into the key themes and variables that should be considered for future research. In most cases, the results of this study work to confirm commonly accepted theories in this research area. In particular, the CSFs identified in this research confirm most commonly accepted theories about the most important factors for implementation success not only for LSS but for change and project management in general. However, the results showed that work environment have a unique, mediating effect in the

relationship between CSFs and LSS success. Further research is needed to understand this effect and develop strategies to leverage work environment assessments and improvement strategies to enable EDs to gain the full potential benefits of LSS and other CI tools. Although this study focused on emergency departments, the results of this study may be more broadly applicable to many different types of people or situations as is reflected in the general nature of the other aspects of the frameworks and models developed.

9.2 Implication for Practice

As mentioned in Hamilton (2018), LSS is the result of the melding of lean principles, which is about the elimination of waste with the data-driven statistical rigor of six sigma to reduce variation and develop consistency. In healthcare organizations, the application of LSS philosophy led to greater control over operations as well as to higher level of service quality (Huang, Li, Wilck & Berg, 2012). Furthermore, the anticipated benefits of LSS implementation in healthcare organizations include significant reductions in medical errors, patient wait times, and control costs (Hummel, 2016).

A significant amount of papers have chronicled the successful implementation of LSS (Pillai, Pundir & Ganapathy, 2012). The following groups or parties may be expected to benefit from the implementation of LSS: customers, employees, and shareholders and investors. In the healthcare sector, the main customers are the patients who seek healthcare services. The patients in particular could benefit from improved quality and the strong drive of healthcare organizations to provide excellent services. Based on statistics, medical errors contributed to nearly 98,000 deaths per year in America that resulted to patient's disabilities and increased cost (Hummel,

2016). With the implementation of LSS, patients could expect lower or even zero cases of medical errors. In addition, noting also that LSS implementation could reduce waiting times, patients could benefit from better and quicker access to healthcare services, especially emergency department services in which time is crucial.

Meanwhile, the employees in the healthcare sector mainly include the doctors, nurses, and administrative professionals who are the providers of healthcare services. The doctors and nurses could benefit from training and professional development and rewards and incentives that are supported by LSS. Administrative professionals have a significant responsibility in driving the LSS project by encouraging the LSS team, offering support, and fostering a desire for success. In LSS principles, employees are given the chance to participate in decision making and to gain access to training and professional development. In addition, employees are also given considerable autonomy to perform their jobs that is perceived to result to greater level of job motivation and satisfaction (Pillai et al, 2012).

Lastly, shareholders and investors could benefit from higher productivity and efficiency and lower rejects and wastes that could translate to better financial performance (Pillai et al, 2012). With better financial performance, shareholders and investors could ensure return on investments. For healthcare organizations, better financial performance could ensure continuous operations and therefore provision of healthcare services.

Overall, the implementation of LSS in healthcare organizations specifically to the emergency department, could benefit major stakeholders including the patients, doctors, nurses, and shareholders. The patients in particular could benefit from reduced waiting time and higher

quality care. The doctors and nurses on the other hand could benefit from training and professional development and rewards and incentives that are supported by LSS. Finally, the shareholders could ensure better financial performance. However, the primary finding is that actively assessing and managing the ED work environment ahead of and during the LSS implementation will support management of the most important CSFs and significantly increase overall changes of success.

There are a number of practical implications that the results of the study and the interpretations drawn from the discussion give to leaders of health facilities managing emergency departments. The primary practical implication is that in the implementation of LSS, it is important to appreciate it is a multifaceted process that includes internal and external stakeholders, the work environment, and organizational resources. Having an appreciation of this reality will ensure the leaders do not tie the whole process around just one facet of the organization. For example, if focus is placed only on the stakeholders without providing the resources they need to deploy the LSS, it is not expected the process will be successful. In the same way, if the resources are made available but the personnel or stakeholders do not have the right training and competence to utilize them, the goals of LSS cannot be realized. Also, if stakeholders are involved and resources provided, it would take the right work environment for the personnel to efficiently use the resources. As part of the multifaceted nature of the implementation of LSS, it is highly recommended that the leaders will not run what is commonly referred to as a one-person show but allow for engagement and involvement from others whose inputs will positively impact on the need to be efficient.

The second practical implication pertains to assessing and managing the WE as an important condition for LSS success. The results of this study show that the WE has a significant effect beyond the traditional CSFs and should be addressed directly. The developed construct can be also

used as a diagnostic by assessing each element within the organization and executing improvement strategies when needed. By this, the leaders should ensure that at every point in time, there is sufficient level of team work to foster staff engagement and collaboration. Also, there should be adequate staff training that allows for the communication of all components and aspects of the LSS implementation among employees. What is more, employees should be provided with the right incentives and rewards that ensure job satisfaction and staff motivation. If all these provisions are made, it is strongly anticipated that employees will always remain committed to their roles with the implementation process. Furthermore, utilizing the framework within an ED will help to enhance staff involvement as well as respect for staff aspects which are essential for effective LSS implementation.

9.3 Limitation

Although the specific limitations for each study were discussed in the respective chapters, a few overarching limitations of this dissertation should be noted. First, the research data of this dissertation were primarily collected from academic and professional healthcare experts, who have experience in implementing LSS in emergency departments. This has illustrated benchmarking highlights of the developed framework. However, the participants' biases and the moderate rate of responses could be limitations of the study. As the expert study relies on experts' opinions and perspectives based in their experience and knowledge, there may be viewpoints on the LSS implementation process are not identified. Wherefore, a pilot test analysis was done to evaluate the reliability of the developed survey questionnaire and validate the applicability of the developed

framework in determining the factors that affect the successful implementation of LSS in emergency departments.

Furthermore, this study was limited to the importance of LSS implementation, there was a lack of determining whether other quality initiatives and prior improvement projects impact the failure or success of LSS project in emergency departments. Despite the role of each critical success factors on LSS implementation is essential, poor implementation of quality initiatives would lead to failure of quality programs. This study was not able to determine whether the pervious quality initiatives projects would affect the implementation of LSS. As Krueger et al. (2014) mentioned, there is a supported link between the LSS and the other quality initiatives programs such as TQM, Baldrige, and ISO. Thus, the future research should be able to investigate the importance of the other quality initiatives programs on LSS projects. Moreover, after developing appropriate sets of survey questionnaire, the future studies should conduct an empirical study to identify the factors that affect the implementation of other quality initiative programs such as Six Sigma, Lean, and TQM.

Additionally, there was a limitation due to the received responses; as all participants were from LSS practitioners, while the perspectives of other groups of hospital staff members, such as upper management, middle management, frontline staff, and operators, were underrepresented. In that regard, a future extension to this study should involve all these groups to explore different perception about the implementation of LSS in emergency department to explore whether different opinions exist among administrative professional, medical professionals, and academic researchers with regard to successful factors of LSS projects. Although this is acceptable for an

expert study, future studies should have broader quality healthcare experts and medical professionals and gather more responses for analysis.

In addition, it is suggested for other researchers to build on this study based on its conclusion on the impact of workplace environment on LSS. It would be noted that results pertaining to the work environment were collected through the use of a survey, which is a form of quantitative research method. While this quantitative research method helped the researcher to achieve the expected goal of the study, its limitation was that it did not allow for in-depth and thorough data collection procedure that would understand why the identified relationship existed. It is thus suggested for future researchers to use qualitative research method to delve deep into the reasons and drivers behind each of the six main elements of work environment that make them particularly important and outstanding in influencing the outcome of LSS. It is strongly anticipated that if leaders get to know and understand the reasons and drivers behind the factors that is when they will be motivated to pursue their use since they will be convinced about how they form a component of the critical success factors for LSS.

Finally, this study is an exploratory study and the primary goal was to develop a construct for the elements of the WE as well as to create some simple quantitative models of LSS success in ED given the work environment context to contribute to the current theory of LSS implementation success. Therefore, the future work should focus on expanding the sample of experts and can compare the sample of experts in this study to the sample of new participants. In addition, single item constructs were used for the CSFs to ensure an adequate sample and focus for the WE construct development. However, a large-scale survey study using multi-item constructs for all variables (leveraging the newly developed WE construct) is needed to further refine the model.

9.4 Future Research

Future extensions of this research will focus on further refining and validating the empirical model through two phases. First, multi-item constructs have been developed from the results of this study including adapting existing items or constructs (Appendix E) to use for future work to focus on developing the CSFs construct of LSS implementation using a wider survey in order to get larger sample size and develop stronger statistical models. A large-scale survey study should be conducted to collect a sufficient sample of professionals with direct experience to test the newly developed construct for WE combined with the multi-item constructs for the CSFs and implementation success. This study will support more advanced statistical modeling providing deeper insights to support the development of success strategies. This study will focus on refining multi-item constructs for all CSFs, WE, and LSS implementation success to support more advanced empirical investigations of these relationships as well as provide constructs for measuring and monitoring these variables during LSS implementations in ED.

The second phase of future research focuses on conducting experimental and field studies (i.e., case studies and action research) to validate the final statistical model. The Define-Measure-Analyze-Improve-Control (DMAIC) (Mandahawi et al., 2010) will generally be preferred. The reason for selecting this methodology in the validation of the LSS is because of its popularity with medical practitioners when a process exists in a company or an institution without being affected by the expectations of the customers (Garza-reyes, 2015). Effective testing of the LSS is critical because it will ensure that the project achieves the intended objectives where errors in the hospital processes and operations are minimal and time efficiency is improved (Yadav & Desai, 2016).

Besides, maintaining that these results will always be consistent and reliable is critical before the project is finally implemented.

Taking the project further to empirical models will require starting with a model in the process of the “black box” type in which continuous or discrete input factors will be put under control (Mandahawi et al., 2010). This means that the experimenter will vary the variables at will to get various measurable outputs, which will be assumed as being continuous. Data from the experiment will be utilized in deriving empirical models that will link the outputs to the inputs. The experiment will account for all the uncontrolled factors that will be identified. The uncontrolled factors could include different machines used in hospitals for operation and other functions and the operators.

After testing the LSS project through experiments and empirical models and finding that it is effective in the ED to improve the identified issues, the model will be tested in an actual ED in a hospital. Testing will be integrated gradually in one section of the ED according to the defined parameters and results are taken. These results will be analyzed against the control data used as the benchmark for the required results. The data will guide changes to improve, change or maintain the course. In addition, conducting qualitative and mixed-methods case studies will be used to collect nuanced evidence.

Convincing practitioners and healthcare systems, such as the Saudi Arabia government, to use the results of this research to guide LSS projects in the ED of the hospitals will not be a difficult task. However, it will not be an obvious task. However, it will be a difficult task talking

to key influencers of decision making in the health sector to get buy-in considering the issue is focused on the work environment.

Among the actions that will undertake in having the LSS accepted and implemented in hospitals is familiarizing the decision-makers and influencers with the model, and talking to the key stakeholders in the healthcare sector to make them aware of the model. It is also important to demonstrate how the model will help in saving time, minimize defects and errors in the medical field while increasing efficiency, which will be achieved through empirical case studies. Further, demonstrating how it will achieve this performance and including cases of the countries and hospitals that are using similar models elsewhere to show the benefits that have been realized will increase the ease of convincing industry professionals to adopt the LSS model for emergency departments. For example, Saudi Vision 2030 is a strategic framework to reduce Saudi Arabia's dependence on oil, diversify its economy, and develop public service sectors such as health, education, infrastructure, recreation, and tourism. So, one of the pillars of Vision 2030 is focusing on developing health facilities and increasing their operational efficiency. As well as the interest in providing high-quality services and caring for human health better through several programs and initiatives. LSS is an important tool to support these initiatives due to its effectiveness in achieving positive outcomes through improving processes. Particularly in emergency departments, which play a critical role in the health and sustainability of societies.

9.5 References

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APPENDIX A: STUDY IRB APPROVAL



UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board

FWA00000351
IRB00001138
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

EXEMPTION DETERMINATION

November 5, 2019

Dear Elaf Makkawi:

On 11/5/2019, the IRB determined the following submission to be human subjects research that is exempt from regulation:

Type of Review:	Initial Study, Exempt Category
Title:	EXPERT STUDY ON SUCCESSFUL IMPLEMENTATION OF LEAN SIX SIGMA IN EMERGENCY DEPARTMENT
Investigator:	Elaf Makkawi
IRB ID:	STUDY00001029
Funding:	None
Grant ID:	None

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made, and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request so that IRB records will be accurate.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

Adrienne Showman

Designated Reviewer

APPENDIX B: SURVEY INSTRUMENTS



UNIVERSITY OF
CENTRAL FLORIDA

EXPLANATION OF RESEARCH

Title of Project: Successful factors of lean six sigma implementation in emergency department

Principal Investigator: Elaf Makkawi

Faculty Supervisor: Dr. Heather Keathley

You have been invited to take part in a research study. Whether you take part is up to you.

The objective of this study is to identify factors that affect successful implementation of Lean Six Sigma (LSS) in emergency departments as well as explore the impact of work environment on the reduction of patient length of stay. This research is a part of a doctoral study being conducted at the University of Central Florida. Identifying these actors and evaluating their relative impact on implementation success will support the research team in their efforts to develop strategies to improve LSS implementation in practice.

You have been identified as a potential participant in this *Experts Study*, which consists of an online, semi-structured questionnaire that takes approximately 25- 30 minutes to complete. The study will include 30-50 academic and industry experts providing valuable insights for the next phases of this doctoral study. Participants must be 18 years of age or older and have quality management experience in healthcare to participate in this study. You may be contacted for the second phase of this expert study; however, you may opt out of participating in the second phase. It is important to note that there are no correct answers, your participation in this survey is completely voluntary, and you may opt out of answering any question in the survey. This survey is anonymous, and the data will only be reported in aggregated form.

Study contact for questions about the study or to report a problem:

If you have any questions, concerns, or complaints please contact Elaf Makkawi, Graduate Student, Industrial Engineering and Management Systems Program, College of Engineering and Computer Science, (407) 864-3534 or Dr. Heather Keathley, Faculty Supervisor, Department of Industrial Engineering and Management Systems at (407) 823-4745 or by email at heather.keathley@ucf.edu.

IRB contact about your rights in the study or to report a complaint:

Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been determined to be exempted from IRB review unless changes are made. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

Principal Investigator: Elaf Makkawi

Faculty Supervisor: Heather Keathley, Ph.D.

APPENDIX C: SURVEY QUESTIONNAIRE ROUND 1

SECTION 1: General Demographic Information

This section consists of multiple questions to obtain basic information about your background.

Q1. Briefly describe your current professional position.

Q2. Which of the following best describes your professional experience?

- Academic Researcher
- Industry Professional
- Others _____

Q3. How many years of experience do you have in quality management or quality improvement?

Q4. Approximately how many Lean Six Sigma projects have you implemented?

Q5. In what countries have you implemented Lean Six Sigma projects?

Q6. What type of organizations have you implemented Lean Six Sigma project in?

- Hospital
- Emergency Department
- Urgent Care
- Others _____

Q7. Which of the following roles were represented in the Lean Six Sigma projects that you participated in? (select all that apply)

- Admin
- Management
- Doctors
- Nurses
- Other: _____

Q8. What was the motivation for the Lean Six Sigma projects that you have participated in? (select all that apply)

- Mandated
- Self-driven
- Part of a continuous improvement program

- Other: _____

Q9. What is the highest level of training/certification that you have achieved? (select one)

- Champion
- Master Black Belt
- Black Belt
- Green Belt
- Sponsor
- Other _____

Q10. What role/roles have you served during a Lean Six Sigma implementation? (select all that apply)

- Champion
- Master Black Belt
- Black Belt
- Green Belt
- Sponsor
- Researcher
- Facilitator
- Consultant
- Other _____

Q11. Which of the following Lean Six Sigma tools have you used during an implementation? (select all that apply)

- The 5s System
- Kaizen
- DMAIC Roadmap
- Pareto Chart
- Value Stream Mapping
- Failure Mode and Effect Analysis (FMEA)
- Fishbone Diagram
- Histogram
- Regression Model
- Other _____

Q12. Which of the following outcomes were achieved by implementing Lean Six Sigma in the Emergency Department (ED)? (select all that apply)

- Reduced error
- Improved patient flow
- Improved processes
- Reduced Patient Length of Stay (LOS)
- Improved laboratory efficiency
- Other: _____

Q13. To what extent you consider the pervious Lean Six Sigma implementations that you observed and/or participated in successful?

- Completely successful
- Somewhat successful
- Moderately successful
- Somewhat unsuccessful
- Completely unsuccessful

SECTION 2: Open-ended Question

This section consists of multiple questions regarding your experience of implementing LSS in Emergency Departments. It is important to note that there are no correct answers to any of these questions and we are interested in your professional opinion based on your experiences.

Q1. What barriers or challenges have you experienced when implementing Lean Six Sigma in an Emergency Department?

Q2. Conversely, what has facilitated or supported your previous attempts to implement Lean Six Sigma in an Emergency Department?

Q3. In your opinion, what are the outcomes of successfully implementing Lean Six Sigma in an Emergency Department?

Q4. How would you describe a work environment that supports the implementation of Lean Six Sigma in an Emergency Department?

Q5. Conversely, how would you describe a work environment that *does not* support the implementation of Lean Six Sigma in an Emergency Department?

Q6. How important is it for the Emergency Department to provide an appropriate and efficient work environment to aid achieve positive outcomes of the implementation?

Q7. If you have studied patient length of stay (LOS), how do you think that ED work environment affected your ability to reduce patient LOS?

Q8. How do you know when your Lean Six Sigma implementation has been successful?

PILOT TEST (Round 1)

This section includes questions regarding pilot testing the survey. Use the following scale to answer the following questions.

To a small extent	To some extent	To a moderate extent	To a great extent	To a very great extent
1	2	3	4	5

Questions	Scales					Suggestions or Comments
1. To what extent did the content of the questions match the goal of the survey based on your understanding?	1	2	3	4	5	
2. To what extent were the meaning of the questions clear and straightforward?	1	2	3	4	5	
3. To what extent were the questions worded in an appropriate manner?	1	2	3	4	5	
4. To what extent did you have to read the questions more than once to understand what it was asking?	1	2	3	4	5	
5. To what extent was the survey organized in such a way that the questions flowed smoothly through the different categories?	1	2	3	4	5	

6. Approximately how long did it take you to complete this survey?

7. Where there any questions that we did not ask or topics that we did not address that you expected to be included in the survey?

8. If you have any other comments or feedback on the survey, please describe them below:

APPENDIX D: SURVEY QUESTIONNAIRE ROUND 2

SECTION 1: General Demographic Information

This section consists of several questions about your background.

Q1. Which of the following best describes your professional experience?

- Academic/ Researcher
- Medical Professional
- Administrative Professional
- Consultant
- Other: _____

Q2. How many years of experience do you have in quality management or quality improvement?

- No formal experience
- Less than one year
- 1 – 5 years
- 5 – 10 years
- More than 10 years

Q3. Approximately how many Lean Six Sigma projects have you implemented in EDs or urgent care facility?

Q4. What is the highest level of training/certification that you have achieved? (select one)

- Master Black Belt
- Black Belt
- Green Belt
- Yellow Belt
- No Certification
- Other: _____

Q5. What role/roles have you served during a Lean Six Sigma implementation in ED? (select all that apply)

- Champion
- Master Black Belt
- Black Belt
- Green Belt
- Sponsor
- Researcher
- Facilitator
- Consultant
- Team member
- Stakeholder

- Other: _____

Considering the last LSS project that you participated in or observed in an ED, please answer the following questions:

Q6. In what country did you implement the Lean Six Sigma project?

Q7. Which of the following groups were represented in the Lean Six Sigma project that you participated in? (select all that apply)

- Administrative professionals
- Management
- Doctors
- Nurses
- Researchers
- Consultants
- Patients
- Students
- Other: _____

Q8. To what extent were the following objectives a focus of the project?

	Not at all	Very little extent	To some extent	Very large extent	To a great extent
Improve Customer Satisfaction	1	2	3	4	5
Reduce Costs	1	2	3	4	5
Reduce Defects	1	2	3	4	5
Reduce Variation	1	2	3	4	5
Improve Throughput	1	2	3	4	5
Reduce Waste	1	2	3	4	5

SECTION 2: Likert-scale Questions

This section consists of three sub-sections of Likert-scale questions to gather information about your experience when implementing LSS in an ED:

1. Factors that affect successful implementation,
2. Outcomes of implementation success,
3. The impact of work environment.

When answering the following questions, please consider the most recent LSS project that you participated in or directly observed in an ED.

2.1 Factors that affect successful implementation

This section consists of questions regarding the factors that affect success of LSS implementation in ED.

Considering the last LSS project that you participated in or observed in an ED, to what extent do you agree with the following statements?

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	Managers were committed to the LSS project.	1	2	3	4	5
2	The culture in the ED supported the LSS project.	1	2	3	4	5
3	The LSS project was aligned with the ED goals.	1	2	3	4	5
4	The LSS team used a well-defined process to select the project.	1	2	3	4	5
5	The LSS team members received sufficient training to support the LSS project.	1	2	3	4	5
6	The LSS team members communicated well during the LSS project.	1	2	3	4	5
8	The ED was organized in a way that supported the LSS Project.	1	2	3	4	5
9	The LSS team had a good understanding of patient requirements.	1	2	3	4	5
10	The LSS team had access to necessary data to complete the project.	1	2	3	4	5

1 1	The LSS team members had sufficient knowledge of LSS concepts.	1	2	3	4	5
1 2	The LSS project was managed effectively.	1	2	3	4	5
1 3	The ED had sufficient IT infrastructure to support the LSS project.	1	2	3	4	5
1 4	The LSS team were given sufficient resources to complete the project.	1	2	3	4	5
1 5	The LSS team utilized appropriate tools and techniques to complete the project.	1	2	3	4	5
1 6	The LSS project had a well-defined timeline.	1	2	3	4	5

Please identify and describe any other factors, not included above, that you believe have an effect on successful implementation of LSS in ED and indicate the extent to which you experienced this effect during the LSS project that you participated in or observed.

2.2 Outcomes of implementation success

This sub-section consists of questions regarding the achievement of outcomes of LSS implementations in ED. Similarly to the previous section, please consider the most recent LSS project that you participated in or observed to answer the following questions.

Considering the last LSS project that you participated in or observed in an ED, to what extent were the following outcomes achieved by the end of the project?

	Not at all	Very little extent	To some extent	Very large extent	To a great extent	The project did not seek to achieve this outcome
Improved patient satisfaction	1	2	3	4	5	6
Improved patient safety	1	2	3	4	5	6
Improved patient flow	1	2	3	4	5	6

Improved clinical care outcomes	1	2	3	4	5	6
Improved reputation of the ED	1	2	3	4	5	6
Reduced Patient Length of Stay	1	2	3	4	5	6
Reduced errors	1	2	3	4	5	6
Eliminated waste	1	2	3	4	5	6
Improved staff performance	1	2	3	4	5	6

Please identify and describe any other important outcomes, not included above, that were achieved after the LSS implementation and indicate the extent to which they were achieved.

Considering the last LSS project that you participated in or observed in an ED, to what extent were the following outcomes that were initially achieved by the LSS project sustained over time?

	Not at all	Very little extent	To some extent	Very large extent	To a great extent	The project did not seek to achieve this outcome
Improved patient satisfaction	1	2	3	4	5	6
Improved patient safety	1	2	3	4	5	6
Improved patient flow	1	2	3	4	5	6
Improved clinical care outcomes	1	2	3	4	5	6
Improved reputation of the hospital	1	2	3	4	5	6
Reduced Patient Length of Stay	1	2	3	4	5	6
Reduced errors	1	2	3	4	5	6
Eliminated waste	1	2	3	4	5	6
Improved staff performance	1	2	3	4	5	6

Overall, to what extent you consider the LSS project to successful?

- Completely successful
- Somewhat successful
- Moderately successful
- Somewhat unsuccessful
- Completely unsuccessful

2.3 The impact of work environment

This sub-section consists of questions regarding the importance of work environment in the achievement of outcomes. Similar to the previous two sections, please consider the most recent LSS project that you participated in or observed to answer the following questions.

Considering the last LSS project that you participated in or observed in an ED, to what extent do you agree with the following statements regarding the ED work environment?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The ED staff were motivated to do their jobs.	1	2	3	4	5
The ED staff received adequate training for their job.	1	2	3	4	5
The ED staff were satisfied with their jobs.	1	2	3	4	5
The ED staff members worked well together as a team.	1	2	3	4	5
The ED staff openly shared information and ideas with the management.	1	2	3	4	5
The ED staff were engaged in their roles.	1	2	3	4	5

Please identify and describe any other important work environment factors, not included above, that you believe affected the success of the LSS project and indicate the extent to which you observed this effect.

Do you have any other comments or thoughts to share regarding your experience implementing LSS projects in ED?

Thank you for your time and contribution. If you would like to receive a brief summary of our findings, please enter an email address below and we will send you the report. (Note that this can be any email and does not need to be associated with your invitation to the survey)

APPENDIX E: MULTI-ITEM CONSTRUCT

Factors that affect successful implementation

This section consists of questions regarding the factors that affect success of LSS implementation in ED.

Considering the last LSS project that you participated in or observed, to what extent do you agree with the following statements?

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	Managers were committed to the LSS project.	1	2	3	4	5
2	Managers were involved in the LSS project.	1	2	3	4	5
3	Managers were supportive of the LSS project.	1	2	3	4	5
4	The culture in the ED supported the LSS project.	1	2	3	4	5
5	People in the ED accepted the LSS project.	1	2	3	4	5
6	The ED was good at changing to adapt to their environment.	1	2	3	4	5
7	The ED had an authoritarian culture.	1	2	3	4	5
8	The LSS project was aligned with the ED goals.	1	2	3	4	5
9	The LSS project was aligned with the ED mission.	1	2	3	4	5
10	The LSS targeted an important outcome for improvement in the ED.	1	2	3	4	5
11	The project selection process was well defined.	1	2	3	4	5
12	The project selection process helped the ED to remain focused on its most important objectives.	1	2	3	4	5
13	The process to prioritize projects was well defined.	1	2	3	4	5
14	The LSS team members received sufficient training to support the LSS project.	1	2	3	4	5
15	The LSS team members had sufficient experience to support the LSS project.	1	2	3	4	5

16	The communication approach used among team members in the LSS project was effective.	1	2	3	4	5
17	The communication approach used among team members in the LSS project helped to increase engagement among LSS team members.	1	2	3	4	5
18	The LSS team members communicated effectively during the LSS project.	1	2	3	4	5
19	The LSS project was a good fit for the ED.	1	2	3	4	5
20	The ED was organized in a way that supported the LSS Project.					
21	The ED was set up so that the LSS team could achieve their objectives.	1	2	3	4	5
22	The LSS team had a good understanding of patient requirements.	1	2	3	4	5
23	The LSS team was good at meeting patients' expectations.	1	2	3	4	5
24	The LSS team used a structured approach for considering patient requirements.	1	2	3	4	5
25	The LSS team was able to maintain patient buy in throughout the LSS project.	1	2	3	4	5
26	One goal was to provide the patients with best in service quality.	1	2	3	4	5
27	The LSS team had access to necessary data to complete the project.	1	2	3	4	5
28	The data provided to the LSS team was accurate.	1	2	3	4	5
29	The LSS team had access to high-quality data.	1	2	3	4	5
30	The LSS team had adequate knowledge of LSS concepts.	1	2	3	4	5
31	The team members were aware of LSS concepts before the project started.	1	2	3	4	5

32	The project management approach was appropriate for the LSS Project.	1	2	3	4	5
33	The project management approach was effective for the LSS Project.	1	2	3	4	5
34	The LSS project was managed well.	1	2	3	4	5
35	The LSS Project Manager improved the quality of LSS project.	1	2	3	4	5
36	The LSS Project managers had sufficient project management skills to support the LSS project.	1	2	3	4	5
37	The ED had sufficient IT infrastructure to support for the LSS project.	1	2	3	4	5
38	The LSS team had sufficient access to IT systems during the project.	1	2	3	4	5
39	Required resources were available during the LSS project.	1	2	3	4	5
40	The LSS team had access to sufficient resources throughout the project.	1	2	3	4	5
41	The ED provided sufficient funding to support the LSS project.	1	2	3	4	5