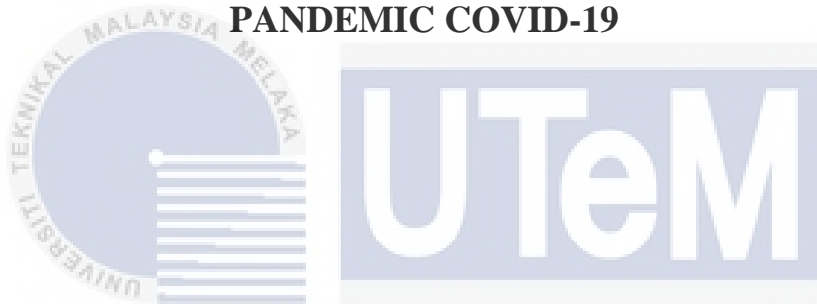




**ANALYSIS ON SUCCESS FACTORS OF LEAN SIX SIGMA  
IMPLEMENTATION IN SME AND IT'S RELEVANCIES IN ERA OF  
PANDEMIC COVID-19**



This report is submitted in accordance with the University Teknikal Malaysia Melaka (UTeM) requirement for a Bachelor Degree of Manufacturing Engineering (Hons.)

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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2021/2022

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Tajuk: **ANALYSIS ON SUCCESS FACTORS OF LEAN SIX SIGMA IMPLEMENTATION IN SME AND IT'S RELEVANCIES IN ERA OF PANDEMIC COVID-19**

Sesi Pengajian: **2021/2022 Semester 2**

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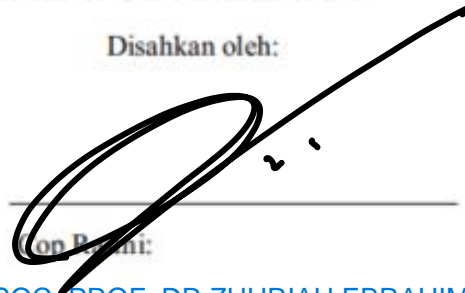
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## APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as

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## ABSTRAK

Pada masa kini, Lean dan Six Sigma (LSS) telah menjadi strategi perniagaan yang amat berkesan. Pelaksanaan LSS di PKS perlu dikaji lebih lanjut untuk mencari status relevan sama ada LSS masih sesuai untuk dilaksanakan atau tidak di SME dalam era Pandemik covid-19. Projek ini terdiri daripada tiga metodologi yang berbeza untuk mencapai setiap objektif yang telah ditetapkan. Laporan projek ini akan menerangkan dengan lebih lanjut tentang metodologi dari segi pengumpulan data, analisis data, dan keputusan akhir. Kajian Penyelidikan ini bertujuan untuk menganalisis faktor kejayaan pelaksanaan Lean Six Sigma dalam Perusahaan Kecil dan Sederhana (PKS) dan perkaitannya dalam era pandemik Covid-19. Kajian penyelidikan ini mengandungi tiga objektif. Objektif pertama adalah untuk menjelaskan dan menyenaraikan faktor kejayaan pelaksanaan LSS di Perusahaan Kecil dan Sederhana (PKS) dengan membaca rujukan kajian lepas. Dapatan untuk objektif satu ialah 13 kelompok faktor kejayaan telah dipilih, dan selepas analisis mendalam, hanya empat faktor kejayaan daripada 13 dipilih untuk menjadi Faktor Kejayaan LSS yang paling biasa. Objektif kedua adalah untuk menganalisis sama ada amalan LSS masih relevan kepada PKS dalam penularan wabak Covid-19 sekarang. Status relevan diputuskan selepas analisis mendalam tentang halangan Covid-19 kepada PKS dan faktor kejayaan LSS menggunakan kaedah perbandingan. Bagi objektif dua, tiga daripada empat faktor kejayaan LSS yang paling biasa adalah tidak relevan untuk dilaksanakan di PKS semasa era pandemik Covid-19. Selepas status relevan setiap faktor kejayaan LSS yang paling biasa diputuskan, objektif ketiga adalah untuk membuat pengesyoran yang boleh dan tidak boleh dilakukan untuk faktor kejayaan yang paling biasa yang tidak relevan. Untuk pengesoran yang 'boleh dilakukan' terdapat 13 pengesyoran, dan untuk 'tidak boleh dilakukan' ada tujuh pengesyoran. Cadangan ini adalah untuk memberi sedikit idea kepada PKS tentang cara menghadapi halangan dalam membantu mencapai kejayaan dalam menggunakan LSS di PKS semasa pandemik Covid-19. Hasil akhir projek ini bermanfaat kerana ianya akan menjadi garis panduan kepada PKS untuk merancang dan mengurus strategi mereka.

## **ABSTRACT**

Nowadays, Lean Six Sigma (LSS) have become a well-established business strategy. Due to the Pandemic covid-19, many obstacles and multiple pressures on the organization and SME industries to implement Lean Six Sigma (LSS). Therefore, the relevancies of implementation of LSS in SME need to study more to find the relevancies status of whether the LSS is still adequate to be implemented or not at SME in the era of Pandemic covid-19. This project is consisted of three different methodologies to achieve each objective that has been set for this project. This project report explains more about the methodology in terms of data collection, data analysis, and the final results. This project aims to analyze the success factors of Lean Six Sigma implementation in SME and its relevancies in the era of pandemic Covid-19. This project consists of three objectives. The first objective is to clarify the success factors of LSS implementation in Small and Medium Enterprises (SMEs) through the literature study. The finding for objective one is that 13 clusters of success factors have been selected, and after a deep analysis, only four success factors out of 13 are chosen to be the most common LSS Success Factors. The second objective is to analyze whether the LSS practice is still relevant to the SME in the current pandemic of Covid-19. The relevancies status is decided after a deep analysis of the obstacles in Covid-19 to SME and the LSS success factors using the comparison method. For objective two, three out of four most common LSS success factors are irrelevant to implementation in SMEs during the era of pandemic Covid 19. After the relevancies status of each of the most common LSS success factors has been decided, the third objective is to make recommendations do(s) and don(s) for the irrelevant most common success factors. For the do(s), there are 13 recommendations and seven for don(s). This recommendation is to give some idea for SMEs on how to encounter the obstacles in the way to help achieve success in implanting LSS at SME during the pandemic Covid-19. This project output is beneficial because the output of these projects will be the guidelines for SME to plan and manage their strategy.

## DEDICATION

Special dedication to my parents, Mr. Lujah Surat and Mrs. Merta Anak Rengkang, for their moral support and understanding of me throughout the semester in completing this project. I want to thank my siblings, friends, and lecturers for being there during my up and down. Thank You So Much and Love You All Forever.



## ACKNOWLEDGEMENT

This project could not have been completed without the contribution and help of the people whose names may not all be mentioned. I have sincerely appreciated all their contributions and am so grateful to acknowledge their presence and give part of their contribution to completing my study research. Nevertheless, I am very grateful and appreciate everything, particularly to the following:

Associate Professor Dr. Zuhriah Binti Ebrahim, who is my project's supervisor, for all the endless support, kind and understanding spirit during the time I am doing this project. Furthermore, to all my lovely and supporting family members, relatives, friends, and whoever in have shared their support, either morally, mentally, or financially. I am thankful. I truly appreciate all your support.

At last, I would also like to thank everyone who is very important in helping me accomplish this report and express my profound apology for not mentioning each of you.



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# CHAPTER 1

## INTRODUCTION

In this section, a few matters will be discussed, and these matters are divided into four subtopics. Those four subtopics are the background of the study, problem statement, objective, scope of the project, the significance of the study, and organization of the report.

### 1.1 Background of study

Nowadays, Lean and Six Sigma have become a well-established business strategy and one of the most well-known and widely accepted management Continuous Improvement (CI) strategies for the manufacturing and service sectors. Continuous Improvement (CI) is the core objective of every organization seeking to achieve quality and operational excellence while also enhancing performance (Assarlind et al., 2012).

Lean Six Sigma is one strategy that depends on the basis of a cohesive team effort to develop execution further or improve performance by deliberately eliminating waste and diminishing variation. Lean Six Sigma is a process improvement methodology that integrate Lean Manufacturing and Six Sigma. to eliminate or minimize the eight types of waste (Muda): overproduction, defects, underutilized talent, waiting, inventory, transportation, extra-processing, and motion. In addition, Lean Six Sigma continuously reduced process flaws and waste known as a non-value-added activity (Summers and Donna, 2011). The execution of Continuous Improvement strategies like Lean Six Sigma (LSS) help business leaders to accomplish quality product, increase production and benefits (Alexander et al., 2019). Up to this point, Lean Six Sigma and Six Sigma have been carried out widely and

effectively in the bigger industrial units. To indicate either Lean Six Sigma is effectively executed, the Critical Success Factors (CSFs) of LSS should be recognized. CSFs are a crucial critical factor for the success of any project, company, or organization. For that reason, special and continuous attention must be given to several important aspects to ensure that they can be adequately implemented, thus ensuring the enterprise's success. In addition, if any essential success criteria are lost or absent throughout the LSS program's creation and execution, this might mean wasted resources, time, money, and effort (Antony and Banuelas, 2002).

However, the success of implement Lean Six Sigma in SMEs is still uncertain nowadays. Many authors already argue about the use of Lean Six Sigma in SMEs industries. Nonetheless, many vital questions remain unanswered nowadays, and future research is required to prove whether application of LSS method will bring success to SMEs industries. In addition, globally has been attacked with pandemic Covid-19 that had so many destructive impacts on the SMEs industry. The Coronavirus pandemic is not only a wellbeing debacle, and the Covid-19 has disrupted the economic sector. This situation will be adding more obstacles and challenges to SMEs to apply Lean Six Sigma, and the success of these initiatives in SMEs will be vaguer. This project will analyze and understand the success factors and obstacles of implementing Lean Six Sigma as the new normal daily life (SOP) during pandemic Covid-19 and determine whether SMEs are still relevant to applying Lean Six Sigma during the pandemic Covid-19 condition because until nowadays uncertainty when this pandemic will end.

## **1.2 Problem Statement**

Business leaders who utilize fruitful Lean Six Sigma (LSS) projects can recognize, analyze, and implement enhancements to processes and eliminate defects to accomplish cost-saving for competitive advantage (Albliwi et al., 2014). Starting from 11 March 2020, World Health Organization (WHO) announce that Covid-19 was a pandemic. As Covid-19 spread, mostly all governments worldwide started to implement strict measures to save lives, for example, disallowing live occasions, requesting that residents stay indoors, and closing organizations and businesses, all of which eased back the Covid-19 spread and forestalled the over-burden of national healthcare systems. Due to the pandemic Covid-19, many

negative impacts, and multiple pressures to the organization from stagnant production, declining demand, tight logistics, and challenges in employment caused by the pandemic Covid-19, the production and operation activities of firms have been genuinely impacted, particularly for Small and Medium Enterprises (SMEs) with limited scale and weak risk management practices. This pandemic situation has enhanced the problem statement that needs to study for this project.

After considering the circumstances and developments of the current situation from the nowadays condition pandemic Covid-19, the current problem that still occurs are there is the slightly study that has been done about the relevancies to applying Lean Six Sigma in pandemic Covid-19 condition. One of the methods implemented by the government around the world to control and slow the Covid-19 spread is by shutting down businesses, which makes SMEs one of the affected by this government order. Hence, all the obstacles to implementing Lean Six Sigma as the new normal daily life (SOP) during pandemic Covid-19 and the relevancies to applying Lean Six Sigma during the pandemic Covid-19 condition must be studied to get a better understanding solution for this problem.

In addition, the effectiveness or success factor of Lean Six Sigma is still uncertain until nowadays in SME industries at the era of pandemic Covid-19, only a few studies have been conducted related to the effectiveness of the use of Lean Six Sigma in SMEs at the era of pandemic covid. Due to this issue, the appropriate study must be conducted to study and identify the scientific answer for the problem statement.

### **1.3 Objectives**

The objectives for this project are stated as below:

- i. To clarify the success factors of Lean Six Sigma implementation in Small Medium Enterprise (SME).
- ii. To analyze whether Lean Six Sigma practice is still relevant to the SMEs in current pandemic Covid-19.
- iii. To recommend do(s) and don't(s) in implementing Lean Six Sigma at SMEs in the era of pandemic Covid-19.



## 1.4 Project Scope

This project will cover on:

- i. Success factors of Lean Six Sigma implementation in manufacturing sector and service sector.
- ii. Analysis of the success factors and also obstacles of implementation Lean Six Sigma in SMEs.
- iii. Analysis of the implementation of new normal in era of pandemic Covid-19.

## 1.5 Project Significances

By conducting this project, it will contribute to the SMEs industries, which can help to give them information on whether Lean Six Sigma practices are relevant and effective enough to be applied in SMEs industries during this pandemic Covid-19 or not. Due to the limited study of the success factors applying Lean Six Sigma in SMEs industries, this project will become the most important study that needs to be conducted to get more information on how far Lean Six Sigma will be effective to be applied by SMEs industries. This project will also recommend the best solution do(s) and don't(s) in implementing Lean Six Sigma in the era of pandemic Covid-19 at the end of the project based on the results achieved through the analysis that has been conducted in this project.

Nowadays, many SMEs have not dared to implement Lean Six Sigma because Lean Six Sigma requires a high cost which can put a burden on SMEs, especially at this time of pandemic Covid-19 (Julian Syaputra et al., 2020). By conducting this project, the results of this study can be guided and give an opinion to the SMEs industries before them to decide whether to implement Lean Six Sigma on their business or not, and this can help the SMEs industry es to plan and can properly manage their strategy when they decide to implement Lean Six Sigma (LSS) in their business. All of this will be found out at the end of this project.

Finally, by conducting this project, the outputs of this project will be recommended do(s) and don't(s) in implementing Lean Six Sigma at SMEs in the era of pandemic Covid-19. These will be beneficial and guidelines for SMEs to plan and manage their strategy.

## **1.6 Organization of the Report**

Chapter 1 explains the overview of the project. This chapter consists of a background of the study, problem statement, significance of the study, the objective, scope of the research, report organization and conclusion.

Chapter 2 reviews the introduction of theory basic concept for Lean Six Sigma. This chapter is also followed by exploring the history of integrating the six sigma and lean. Moreover, the success factors of Lean Six Sigma and application of Lean Six Sigma in SMEs also will be reviewed in this chapter. Next, this chapter also reviews the implementation of Lean Six Sigma in SMEs and all the Covid-19 obstacles for nowadays also explained in this chapter.

Meanwhile, Chapter 3 focuses on the method that will be the approach for the project. All the methods that will be implemented in this research will be explained more such as the research design, research approach, data collection and data analysis of the project. This chapter will discuss the methodology in more detail.

## **CHAPTER 2**

### **LITERATURE REVIEW**

This chapter reviews the previous research related to the Lean Six Sigma background and history of integration of Lean Six Sigma. Moreover, the overviews about the success factors in implementing Lean Six Sigma in industries will be reviewed in this chapter. Finally, this chapter discusses the implementation of Lean Six Sigma in SMEs and the obstacles of pandemic Covid-19 in manufacturing business.

#### **2.1 Lean Six Sigma**

Pepper and Spedding (2010) claim that Lean Six Sigma (LSS) is a management philosophy that integrates two elements of Lean Manufacturing and Six-sigma in order to enhance an organization's processes and results. Lean Six Sigma is one hybrid Continuous Improvement (CI) Initiative. Lean Six Sigma combines the concepts of "Lean Manufacturing" emphasis on waste reduction with the "six sigma" emphasis on quality improvement as a means of increasing efficiency and lowering costs across all processes. Organizations adopt LSS, Lean, and Six Sigma to improve their performance and competitiveness. A recent study by Albliwi et al. (2015) states that from the research made, when it comes to improving operational excellence in manufacturing and other industries, Lean Six Sigma (LSS) has become a popular tool.

### **2.1.1 Lean Manufacturing**

Lean manufacturing broadens the scope of the Toyota production philosophy by encompassing the five components of "the customer management process, the product development process, the enterprise-wide policy emphasizing process and the supplier management process" (Holweg, 2007). The lean vision's base remains a concentrated effort on a single product and its value chain (identification of non-value-added and value-added operations), as well as the goal of eliminating all waste, that known as MUDA, throughout the system's various sections and functions. There have been seven distinct types of garbage identified it is waiting, over production, defects, inventory, motion, over processing and transporting.

The first stage in applying lean by determine non-value-adding and value-added processes. Next, Value Stream Mapping (VSM) arose in the function and keep continues to provide such a reliable qualitative analytical tool this will happen if implemented appropriately (Rother and Shook, 1999) It also gives the scope of a project by identifying the system's existing state and planned future state. Initially, lean manufacturing ideas were applied to huge industrial operations with high volume and low variety Facilities. Top management must demonstrate leadership and commitment in order to embrace and implement the lean method. This necessitates effective communication and feedback. across the organization. The production floor space was reduced in this scenario, resulting in vacant space that maybe sold for the money. These activities are referred to in this article as "common sense"; this can result in lean being ignored as a method of improvement and certain lean tactics being counter-intuitive (reducing inventory).

### **2.1.2 Six Sigma**

As it is now known, Six Sigma invented at Motorola in the 1980s by Bill Smith as a reliability engineer (Brady and Allen, 2006). The phrase "Six Sigma" mention of the statistical measurement of a system's defect rate. It provides a systematic and structured approach to process improvement, reducing defect rate of 3.4 defects per million chances (Brady and Allen, 2006). Pande et al. (2000) presents some interesting examples

distinction around 99 percent quality and the better rate of Six Sigma quality in a variety of different setting to assist clarify the implications of Six Sigma defect rates inside a system. Six Sigma provides structure to process improvement by outlining Deming's plan-do-check-act cycle in greater detail and directing the effort through a five-stage cycle of define-measure-analyze-improve-control (DMAIC) (Andersson et al., 2006). Each step of the DMAIC is associated with a set of techniques and tools, for example design of experiments, response surface methodology, and statistical process control which offer the user with a comprehensive toolbox of techniques for measuring, analyzing, and improving critical processes necessary for bringing the system under control (Keller and Paul, 2004).

As well-known Six Sigma methodology are implemented within a systematic problem-solving methodology known as DMAIC (Define-Measure-Analyze-Improve-Control). The organized steps are as follows: Define the improvement activity's objectives; Measure the present system; Analyze the system for determining how to narrow the gap in between system's or process's current performance and the anticipated outcome; Enhance the system; Supervise the new system. Training key personnel is crucial for properly implementing the DMAIC cycle and achieving meaningful results, as is top management buy-in if the program is to succeed. Management must take an active role in determining which projects to focus freshly trained Six Sigma teams on and ensuring that the necessary resources are accessible (Raisinghani et al., 2005). Prior to commencing on the Six Sigma journey, the responsibilities necessary for implementation must be defined and communicated throughout the company so that everyone involved understands their responsibility (Pande et al., 2000). It is critical to understand Six Sigma as a philosophy and a scientific approach, which is gaining recognition (Keller, 2001).

Six Sigma is well documented in the literature for its application in a range of industries. Motorola and General Electric are the most well-known examples in the manufacturing industry (Pande et al., 2000). However, successful in the construction project and accounting processes (Brewer and Bagranoff, 2004). As with any endeavor at continuous improvement, management commitment and open communication are critical for success. In response, Six Sigma emphasizes quantifiable financial returns through one sequential and disciplined approach. It builds an "infrastructure of champions" within the organization through the introduction of "belt" qualifications (green, black, master black) to lead the charge in data-driven decision-making for improvement efforts (Antony and Bhaiji, 2004).

### **2.1.3 The Combination of Lean and Six Sigma (Lean Six Sigma)**

Individual Lean and Six Sigma programs share certain characteristics, including a concentration on a process of continuous improvement, customer satisfaction, extensive staff involvement, and root cause analysis (Laureani and Antony, 2018). Each of these techniques has been used by numerous firms to enhance their business processes (Aqlan and Al-Fandi, 2018). The hybrid LSS strategy enables organizations to address various distinct issues by combining tools and techniques from both initiatives. The term "Lean Six Sigma" refers to synthesizing lean and Six Sigma idea (Sreedharan et al., 2018). The combination of lean and Six Sigma attempts to improve every aspect of an organization. Whereas Six Sigma is applied by a small number of highly skilled employees within an organization, lean empowers and educates everyone to eliminate non-value tasks. If the two are executed in isolation, the conclusion may be that neither is carried out properly; they will be hampered by one another's organizational needs (Harrison, 2006). Again, this may result in two distinct subcultures within the organization, each competing for the same resources, etc (Smith, 2003).

Lean Six Sigma is also widely acknowledged as a powerful technique for leadership development. Work processes of all types are altered because of these shifts. Lean Six Sigma introduces principles, methodologies, and tools for process improvement. Thus, Lean Six Sigma is a useful tool for leadership development since it prepares leaders for their position as change agents. It is necessary to implement Lean Six Sigma because businesses and individuals require a technique for improving and problem resolution. Efforts to improve processes do not occur on their own. A systematic strategy for improvement is required to increase performance as evaluated by quality, cost, delivery, and customer happiness. Customer requirements are constantly changing and expanding. Cash flow is always crucial to an organization's success. Profitability enhancements generate the funds required to fund innovation and development. Lean Six Sigma outperforms earlier techniques by integrating the people and parts of the process of process improvement (Snee, 2010). Indeed, a large firm aware of initially concentrated on process management, then on customer attention, and finally on process improvement, and ultimately on managerial leadership throughout ten years with little or no connection and integration of the parts.

The five-phase improvement method defines, measures, analyses, improves, and controls (DMAIC) sequences and effectively connects essential statistics and other tools for

process improvement. Snee and Hoerl (2004) emphasized this is not a novel concept and no other approach has accomplished this as effectively.

## **2.2 Critical Success Factors of Lean Six Sigma.**

Over the years, numerous research studies have focused on the benefits of implementing LSS principles in the industry (Dumitrescu et al., 2011) . Nonetheless, numerous studies on essential success criteria for LSS applications in electronics manufacturing services (EMS) directed at multinational corporations (MNCs) in Malaysia indicate that only a small percentage of LSS implementations are effective. Psychogios et al. (2012) identify significant barriers to LSS implementation in their study, including a lack of understanding of LSS, a lack of awareness of the importance of continuous quality improvement programs, and a lack of strategic orientation and working mindset. Thus, variables such as a robust training program, teamwork, and top management commitment have been identified as critical to the success of lean deployment (Piercy and Rich, 2009). Additionally, employee engagement requires an understanding of lean processes and their application in their daily jobs, as well as an organization's awareness and willingness to improve (Radnor and Zoe, 2008), and convincing employees to accept changes to the organization's working culture (Dahlgaard and Park, 2006).

It is critical to understand the critical success factors for LSS practices on business performance in the EMS industry, as measured by operational and organizational performance (Gorantiwar and Shrivastava, 2014). However, successful manufacturing process implementation requires not only the strengthening of standard operating procedures (SOPs) or the use of various tools such as Lean, Six Sigma, kaizen, DMAIC, and others but also the process of matching these tools to the environmental culture and available resources within the organization in order to achieve effective implementation results (Gorantiwar and Shrivastava, 2014).



## **2.2.1 The Relationship Between LSS critical success factors with performances**

Numerous elements contribute to the success of LSS implementation. Critical success factors are critical to the success of any initiative, such that if the factors' associated objectives are not met, the initiative's implementation will fail. According to Jayaraman et al. (2012) critical success factors are characteristics that a business must possess to achieve maximum competitive leverage. Additionally, the scholar emphasizes that critical success determinants are not the aims themselves, but the action required to ensure that organizations achieve their stated goals (Jayaraman et al., 2012). Numerous businesses/organizations face obstacles while implementing Lean Six Sigma using some of the Lean Six Sigma tools. These obstacles could be attributed to factors for example the organization's use of LSS tools/initiatives. Additionally, the problems associated with Lean implementation encompasses all obstacles encountered during the implementation process, including organization's executives, organizational culture, the management, and the technical issues (Taleghani, 2010).

Numerous research publications concluded that top management support is critical for the deployment and implementation of LSS projects to be effective establishes a positive correlation between the LSS's success and the business's financial impact. Psychogios et al. (2012) stated that implementing process management methodologies is doomed to fail without management commitment and support. Additionally, Dahlgaard and Park (2006) discovered that achieving a significant effect on TQM, LSS, and Six Sigma deployment required an organizational culture that is proactive in minimizing waste and achieving organizational excellence through effective leadership. As a result, and it states that management's commitment to LSS practices has a beneficial effect on performance.

Financial competence is a critical aspect in determining a company's ability to implement LSS. Investments in LSS include professional training, consultancy, and software licensing purchases necessary for a well-formulated LSS project. Jayaraman et al. (2012) identified financial capabilities as a success factor for LSS adoption because it requires some investment. Thus, it is hypothesized that the financial capabilities of manufacturing organizations in Malaysia affect the effective deployment of LSS and, as a result, the organizations' performance. The following hypothesis is produced as a result, and it states