



Factors analysis of lean six sigma practices in the Vietnam wood industry

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ABSTRACT

Six sigma is valuable to process control and ensure the stability of product quality. Lean practices or six sigma in isolation cannot remove all types of waste, control the process statistically, and remove process variability. The integrated development of the two approaches, which are known as Lean and six sigma (LSS), may bring out the advantages of both concepts. Although, many enterprises have succeeded with LSS around the world only less than 20% of enterprises achieve and maintain lean activities for the time being. The aim of this research paper is to present the key factors that constitute a successful implementation of LSS in the wood industry in Vietnam through analysis of LSS implementation. A combination of a comprehensive literature review and a site visit to deeply observe by participants observation for 3 LSS projects and interview the key persons involved in the project was employed in this study.

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1. Introduction

Lean and six sigma (LSS) is possibly the most popular and commonly used by many companies and will be the standard manufacturing model in the 21st century. The advantage of lean is the ability to reduce production costs through the elimination of all types of waste while six sigma emphasizes effectiveness issues, such as variation and defect reduction, as well as process assessment. It can guide a company to become a world-class organization (Papadopoulou and Özbayrak, 2005). This approach to eliminating waste has made a substantial impact on manufacturing companies, resulting in higher performance enhancement and significant improvement in delivery, quality, flexibility, and production cost (Fullerton and McWatters, 2001).

There are seven types of waste transportation, inventory, motion, wait, over-production, over-processing, and defects (Ohno, 1988; Pascal, 2007). Many companies have saved a lot of money by reducing production costs by eliminating waste, and other companies around the world also succeeded in LSS implementation (Coronado and Antony, 2002).

However, not all enterprises can claim to have had the same benefits, there is only fewer than 20 percent of the companies succeeded when implementing LSS after 1 year.

LSS has come in Vietnam for more than 30 years and now most enterprises in Vietnam are familiar with LSS as a method for organizations to improve production productivity, reduce production cost, improve product quality, and just-in-time delivery. Some Vietnamese enterprises applied some tools and techniques of LSS and achieved very encouraging results (Minh et al., 2015). Anyway, LSS in Vietnam is still a new concept for most domestic organizations. As mentioned above, the ratio of successful enterprises in Vietnam is not very high too, only less than 10 percent (Minh et al., 2015; Minh et al., 2014).

The purpose of this research is to indicate some of the factors that are perceived to be critical in the successful application of LSS through an experience in the wood sector in Vietnam. The exploration of LSS's success factors is a good lesson for other enterprises in Vietnam when deploying LSS into their production lines.

2. Literature review

2.1. Lean six sigma

Lean manufacturing (LM) or lean is a comprehensive set of techniques (Wilson, 2010) that doing more with less—less time, less space, less human effort, less material, and less machinery while giving customers what they want (Pascal, 2007). It is

a systematic approach to eliminating the sources of loss from entire value streams in order to close the gap between actual performance and the requirements of customers and shareholders. Therefore, the target of LM is to optimize cost, quality, and delivery while improving safety. To meet this objective, LM tries to eliminate three key sources of loss from the operating system: Waste, variability, and inflexibility. LM is a secret weapon responsible for waste elimination and quality improvement, cost reduction, and a comprehensive philosophy for structuring, operating, controlling, managing, and continuously improving industrial production systems (Minh and Kien, 2021).

The goal of LM is the reduction of waste in human effort, inventory, time to market, and manufacturing space to become highly responsive to customer demand while producing good quality products in an efficient and economical manner (Detty and Yingling, 2000; Ohno, 1988; Pascal, 2007).

LM is also a multi-dimensional approach that encompasses management practices (Shan and Ward, 2003), a broad collection of principles and practices that can improve corporate performance, a manufacturing philosophy that shortens the Lead time and reduce costs via eliminating wastes (MUDA) yet improving quality, employee skills and job satisfaction. Besides that, Nordin et al. (2011) pointed out the ultimate goal of LM is to create a smooth production and high-quality organization that is able to produce finished products concerning the customers' demand in the quality looked for "zero waste."

Six sigma is integrated as a complementary tool in Kaizen events. In other organizations, six sigma is the other way around—that is, the principal program and the tools of lean Production are applied within the DMAIC framework (a step-by-step approach or road map using Define, Measure, Analyze, Improve, and Control phases) (Scheller et al., 2018).

Six sigma was pioneered earlier in the 1980s by Bill Smith of Motorola; six sigma became popular as a business excellence strategy in 1995 when it was executed in General Electric by Jack Welch (Parmar and Desai, 2019). One of the simplified definitions of six sigma is a problem-based approach to solving definite problems of the company. The characteristic of six sigma is a sorted out and precise strategy for specific process improvement and new product and service improvement that depends on statistical and scientific techniques to make sensational reductions in customer-defined defects of products (Linderman et al., 2003).

LSS integrates the concept of LM concepts and the DMAIC methodology of six sigma (Scheller et al., 2018). The LSS can be considered a six sigma DMAIC methodology-driven approach which normally uses various lean tools and techniques to identify various problems in the organization. However, LSS divides opinions, and there is still no clear structured model for its application. Therefore, it is still necessary to conduct research on the implementation of LSS

practices and identify the success factors (Parmar and Desai, 2019).

2.2. Key success factors for LSS implementation

Key success factors (KSFs) are the limited number of areas in which satisfactory results will ensure successful competitive performance for the individual, department, or organization. KSFs are the few areas where "things must go right" for the business to flourish and for the manager's goals to be attained. KSFs are very important in ensuring the success of LSS implementation and avoiding the failure risk such as will create loss to the organization's cost, time, and employee effort (Siegel et al., 2019). The KSFs approach has been widely adopted and used in a variety of different fields of study to determine key factors which are essential to the success of any program or technique (Achanga et al., 2006; Howell, 2009).

Although, many companies are implementing LSS tools and techniques. In fact, companies are faced with some challenges and difficulties, which could be avoided and overcome by identifying the KSFs of LSS tools. In other words, there are so many KSFs if identified and well understood that will support the overcome of these obstacles and difficulties. Therefore, studying and understanding KSFs of LSS implementation is very essential.

There are many papers published on KSFs with LSS and productivity improvement initiatives (Nguyen, 2018). Table 1 shows some factors indicated by the authors in previous works.

Table 1 presents the number of critical success factors from research. However, there has been some disagreement among the reviewed articles. Some factors have been mentioned in most of the research (Top management commitment, culture change, training, communication, etc) while others have counted in only one or two research. Therefore, it is necessary to conduct qualitative research to review and confirm factors that are critical to success with LSS implementation.

3. Research methodology

A qualitative through case study approach will be conducted for this paper. Qualitative research produces findings without the use of statistical procedures (Yin, 2013) and provides insights and deep understanding, while quantitative research tries to generalize the insights to a population (Perry, 1998). To understand the success of LSS during implementation in an enterprise, researchers have to involve and participate in the project to know how LSS projects drive, and why one project has failed or succeeded.

A combination technique for data collection has been employed in this study including a literature review, observation of companies' practices, and interview of key persons in LSS projects. The literature review conducted extensively at the initial stages of research demonstrated the existence of LSS

knowledge and KSFs. The review has not provided sufficient information on issues that affect the successful implementation of LSS in the company. Therefore, there is a need for further research within the existing companies that had implemented the LSS concept previously. The idea behind this move was to investigate further, so as to determine such factors deemed critical for LSS implementation.

The data collection process is conducted from three lean projects in four months (from Apr 2021 to May 2022). The main techniques used for data

collection include participant observation and personal interviews. Information from the observation data collection sheet was analyzed and used for the preparation of the interviewing process. Personal interviews were conducted through prepared semi-structured questionnaires. They involved a number of key personnel in the company that included the general workforce of the companies concerned and involved in the LSS project.

Table 1: Synthesize key success factors for LSS implementation

KSFs	References
Strategic driver related	
1. Top management involvement and direction	(Achanga et al., 2006; Alaskari et al., 2012; Alhuraish et al., 2014; Bakàs et al., 2011; Coronado and Antony, 2002; Nah and Delgado, 2006; Kumar et al., 2009; Leong and Teh, 2012; Rose et al., 2014; Sabry, 2014; Pingyu and Yu, 2010)
2. Clear goals and objectives	(Achanga et al., 2006; Alaskari et al., 2012; Alhuraish et al., 2014; Nah and Delgado, 2006; Kumar et al., 2009)
3. LSS as a long-term program	(Achanga et al., 2006; Kumar et al., 2009; Wilson, 2010; Womack and Jones, 2003)
Human resources related	
4. Employee involvement and commitment	(Ab Wahid and Corner, 2011; Alaskari et al., 2012; Bakàs et al., 2011; Coronado and Antony, 2002; Hibadullah et al., 2014; Kumar et al., 2009; Rose et al., 2014; Taner, 2013)
5. All management-level involvement	(Achanga et al., 2006; Alaskari et al., 2012; Howell, 2009; Kumar et al., 2009)
6. Effective communication	(Alaskari et al., 2012; Coronado and Antony, 2002; Nah and Delgado, 2006; Rose et al., 2014; Taner, 2013; Pingyu and Yu, 2010)
7. Empowered decision-makers	(Howell, 2009; Rose et al., 2014; Sabry, 2014)
Change management related	
8. Culture change	(Achanga et al., 2006; Alaskari et al., 2012; Alhuraish et al., 2014; Coronado and Antony, 2002; Kumar et al., 2009; Kundu and Manohar, 2012; Leong and Teh, 2012; Rose et al., 2014)
9. Team Leadership/management skills	(Achanga et al., 2006; Alaskari et al., 2012; Howell, 2009; Kundu and Manohar, 2012)
10. Cross-function management	(Howell, 2009; Taner, 2013)
11. Teamwork ability	(Ab Wahid and Corner, 2011; Nah and Delgado, 2006; Leong and Teh, 2012)
Process related	
12. Understand tools and techniques	(Achanga et al., 2006; Alhuraish et al., 2014; Coronado and Antony, 2002; Nah and Delgado, 2006; Hibadullah et al., 2014; Rose et al., 2014)
13. Training, education, coaching, and consulting	(Alaskari et al., 2012; Alhuraish et al., 2014; Coronado and Antony, 2002; Kumar et al., 2009; Kundu and Manohar, 2012; Leong and Teh, 2012; Rose et al., 2014; Sabry, 2014)
14. Integrated into daily work/Continuous improvement	(Howell, 2009; Rose et al., 2014)
15. Problem-solving ability	(Alaskari et al., 2012; Howell, 2009; Sabry, 2014)
16. Measurement (KPI)	(Bakàs et al., 2011; Kundu and Manohar, 2012; Pingyu and Yu, 2010)
17. Rewarding/Recognition	(Ab Wahid and Corner, 2011; Alhuraish et al., 2014; Howell, 2009)
Infrastructure related	
18. Resources allocated	(Achanga et al., 2006; Alaskari et al., 2012; Alhuraish et al., 2014; Bakàs et al., 2011; Howell, 2009; Kundu and Manohar, 2012; Sabry, 2014)
19. Facilities	(Alhuraish et al., 2014; Coronado and Antony, 2002; Kumar et al., 2009; Leong and Teh, 2012)
20. IT capacity	(Alhuraish et al., 2014; Kumar et al., 2009; Al Sharif, 2011)
External management related	
21. Linking to suppliers/vendors	(Alaskari et al., 2012; Alhuraish et al., 2014; Coronado and Antony, 2002; Kumar et al., 2009; Sabry, 2014)
22. Linking to customers	(Alaskari et al., 2012; Alhuraish et al., 2014; Coronado and Antony, 2002; Hibadullah et al., 2014; Kumar et al., 2009; Rose et al., 2014; Sabry, 2014)
Flexibility related	
23. Project prioritization and selection	(Alaskari et al., 2012; Alhuraish et al., 2014; Coronado and Antony, 2002; Nah and Delgado, 2006; Howell, 2009; Kumar et al., 2009)
24. Use basic tools and techniques first	(Nah and Delgado, 2006; Sabry, 2014)
25. Simplify procedure and process	(Minh et al., 2014; Pascal, 2007; Sabry, 2014)

In order to find out the perspectives of companies on the factors which are critical for LSS. A number of questions were prepared to enable the extraction of ideas that give a true reflection on the interviewee's perception of these factors. Preparing a number of questions that embodied the companies' definition of LSS and whether that company had implemented LSS before. The key questions asked in the semi-structured questionnaires as suggested by Achanga et al. (2006) are as follows:

- Background of LSS implementation?
- Motivated the company to implement LSS?
- How many people were involved in the projects?

- LSS training had been conducted, did the staff undertake it?
- The faced barriers and how was your team overcome?
- What were the resources involved in the implementation of LSS?
- What are the factors that lead to successfully implemented? Why?

4. Research results

After participating in three LSS projects and interviewing key persons in the division of LSS

promotion, the key factors that impact LSS success are explored. The profile of three LSS projects and interviewees implemented in different factories from

case companies from April 2021 to May 2022 is shown in Table 2 and Table 3.

Table 2: LSS project profile

#	LSS Project	Duration	Scope
1	Production quality and efficiency improvement	April, 2021~ Jul, 2021	Company-wide
2	Standardized work improvement	Jun, 2021 ~ Sep, 2021	Company-wide
3	Defective reduction (For export wooden furniture)	Feb, 2022 ~ May, 2022	Company-wide

Table 3: Number of interviewees who participated in the study

#	Project name	Top management	Middle management	Front line employee
1	Production quality and efficiency improvement (Prj. No.1)	1- DGM	2- MA, GL	1- TL
2	Standardized work improvement (Prj. No.2)	1- DGM	2- MA, AM	1- SL
3	Defective reduction (Prj. No.3)	2- DGM	1- MA	X

DGM: Deputy General Manager, MA: Manager, AM: Assistant Manager, GL: Group Leader, TL: Team Leader, SL: Sub-leader

After participating in three LSS projects listed in Table 2 and interviewing key persons listed in Table 3, this research investigation has realized ten key main factors that are fundamental and hence critical for the implementation of LSS from the list of 25 factors indicated in the literature. They include: (1) Top management involvement and direction, (2) Clear goals and objectives (3) Employee commitment, (4) Effective communication (5) Team leadership and management, (6) resources allocated, (7) Cross-function management, (8) understand LSS tools and techniques, (9) training, education, coaching and consulting, and (10) measurement (KPI). In the context of LSS project implementation, these KSFs present the essential ingredients without which a project stands little chance of success.

In the ten identified factors, it has been hypothesized that factors “Top management involvement and direction” are the most critical ones

in determining the success of an LSS project. Strong commitment and support through daily, and weekly meeting participation is the cornerstone to the success of implementing any idea within an organization. The success of any project is firstly dependent on top management commitment. Factor “Resources allocated” is the second critical factor for ensuring successful of LSS and a crucial factor in the determination of any successful project. This factor contains three main elements time allocated, finance allocated and human resource allocated. We understand that in the application of LSS or any other productivity improvement initiative within any organization, we need time, money, and someone to do the things.

The results of this research indicated that there are differences between critical LSS factors in various projects. Table 4 shows detailed KSFs for three projects in research.

Table 4: Key factors for success in various LSS projects

Factor	Prj. No. 1	Prj. No. 2	Prj. No. 3
1. Top management involvement and direction	x	x	x
2. Clear goals and objectives	x	x	x
3. LSS as a long-term program	o	o	o
4. Employee involvement and commitment	x	x	x
5. All management-level involvement	o	o	o
6. Effective communication	x	x	x
7. Empowered decision-makers	x	o	o
8. Culture change	o	o	o
9. Team Leadership/management skills	x	x	x
10. Cross-function management	x	x	x
11. Teamwork ability	x	o	o
12. Understand tools and techniques	x	x	x
13. Training, education, coaching, and consulting	x	x	x
14. Integrated into daily work/Continuous improvement	o	o	o
15. Problem-solving ability	o	o	x
16. Measurement (KPI)	x	x	x
17. Rewarding/Recognition	o	o	o
18. Resources allocated	x	x	x
19. Facilities	x	o	o
20. IT capacity	o	x	o
21. Linking to suppliers/vendors	o	o	x
22. Linking to customers	o	o	x
23. Project prioritization and selection	o	o	o
24. Use basic tools and techniques first	o	o	o
25. Simplify procedure and process	o	o	o

x: key factor, o: not key

5. Conclusion

This paper has described the realization of KSFs determining successful implementation of LSS via

three LSS projects. The identified KSFs have provided useful insight for the enhancement of the critical decision-making process and are needed for the strategy of LSS application in organizations. In

order to achieve the full potential of LSS applications, it is important to take these factors into consideration. If any of these ingredients are missing during the implementation of LSS projects, it would be then the difference between a successful implementation and a complete waste of effort, time, and money.

This paper has described the realization of key success factors determining the successful implementation of LSS within an enterprise environment through the case study. The identified success factors have provided useful insight for the delivery of corporate strategic improvement toward the implementation of LSS. The results of this study were supported and consistent with the previous research and some of the insights gained provided new and unique perspectives on Vietnam enterprises' characteristics.

Although this paper produced useful and interesting findings, there are several limitations. This study was conducted limit in three LSS projects. Therefore, some factors can be critical for enterprises but are not critical for others such as "Culture change," "Project prioritization and selection," "Use basic tools and techniques first" or "Simplify procedure and process." These factors should be analyzed in the following research. The next stage of the research is the need to evaluate these factors in manufacturing enterprises which would enable us to understand their priority of importance. This study will also make attempt to compare the different rankings of the KSFs in various companies.

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Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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