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INCREASING THE IMPLEMENTATION CAPABILITY OF LEAN SIX SIGMA THROUGH THE INTEGRATION WITH A LEARNING ORGANISATION CONCEPT

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Abstract
Companies throughout the world have always been working on improving their operations and challenging their bottom lines. With a the increased competition triggered by globalization, it has become vital for them to run their businesses in the most efficient and effective ways.

Keywords
concept, lean, six sigma, organisation.

1. Introduction

Currently, various approaches to production processes improvement exist and caused financial success and competitive advantages. However, the synergy of Lean and Six Sigma (LSS) is considered to be the most widely applied approach to changes and improvement. It embraces the best aspects of both methodologies and helps to achieve positive results in the organizational performance improvement, if applied in a proper way. These philosophies originated separately, but merged over time and formed a Lean Six Sigma methodology that continues to develop. The development course has now moved towards the analysis of LSS and the concept of a "learning organization" (LO), as introduced by Peter Senge in his book *Fifth Discipline* [35]. The LO concept is not only similar to lean philosophy, but it is rather embedded within it.

The literature review covers LSS development beginning from the early stages up to the current state and future perspectives of adding up LO principles. A brief insight into Lean and Six Sigma as separate methodologies is given, followed by a more detailed review of a combined LSS approach as well as LO concept. In the conclusive part of the review, the idea of combining LSS and LO approaches is being articulated to help to determine the research questions [16, 44].

2. Evolution of Lean Six Sigma

This section describes the evolution of LSS methodology and provides a brief insight into Lean and Six Sigma as separate methodologies as well as to the LSS holistic approach [8]. The section ends with a description of LSS and LO relation.

2.1. Lean

Since the early 1970s, researchers have been studying the lean concept while practitioners were using it to improve businesses. It resulted in a broad body of knowledge related to the topic that continues to develop and grow.

The term "lean production" is used to refer to manufacturing techniques or tools developed and used by Toyota Motor Company [18]. The concept was earlier described by Womack et al. [41] to sum up the results of a research conducted by Massachusetts Institute of Technology (MIT) called International Motor Vehicle Program (IMVP) and the term itself was coined by John Krafcik in 1988, a member of the research team. Lean production is also commonly referred to the Toyota Production System (TPS). Currently, such terms as lean manufacturing, lean, lean philosophy, lean methodology, etc. appear in scholar works as well as practitioners vocabulary. Notwithstanding the variety of terms, the core idea behind them lies in the reduction, or at

best elimination of non-value adding activities in a business process to maximize customer value.

Table 1
"Wastes" in Lean paradigm. Source: Adapted from Ohno [25] and Zhang [43].

Types of Waste		Description
T	Transportation	Excessive transportation of work-in-process (WIP) or goods
I	Inventory	Excess of material and information
M	Motion	Unnecessary human movements
W	Waiting	Delays and idle time
O	Overproduction	Production of products/services ahead of demand
O	Over processing	Not required process steps
D	Defects	Off-specification outcomes
S	Skills	Not utilised capabilities

Initially, seven types of waste (TIMWOOD) were developed by Taiici Ohno, Toyota's Chief Engineer. Later, the eighth type of waste, "skills", was added. To reduce or at best eliminate waste, it is necessary to clearly understand what the waste is and where it is. Wastes are easier to be found in manufacturing environment than in a service sector, there are various techniques for tackling each type of waste depending on the conditions of processes or the overall business [31].

Table 2
Four decades of Lean. Source: Adapted from Stone [38].

Year	Phase	Description
1970–1990	Discovery	Oil crisis in 1973 triggered an interest in Japanese management methods
1991–1996	Dissemination	Principles of Lean applied in US manufacturing sector known as TQM, JIT, etc.
1997–2000	Implementation	Lean thinking becomes an integral part of strategic management
2001–2005	Enterprise	Lean goes beyond manufacturing to service sector organisations
2006–2009	Performance	Attempts to assess the level of leanness, culture development and human resource aspects
2009– present	Synergy	Lean is being applied to all functional areas of businesses and addresses environmental issues

Womack and Jones [40] pay attention to the fact that Lean is not only about waste and a tactic or short-term cost reduction program, but rather a way of thinking and acting for the entire organization. Kyle and Stone [38] has studied the lean related literature for the last forty years and marked out four phases of lean research development (Table 2).

Key findings of the lean literature review revealed by Kyle and Stone [38] and Seddon and Caulkin [34] include:

- lean thinking originated in manufacturing and is currently being applied not only in the shop floor, but through all the organisations of all all branches of industry,
- interest in the research of Lean and its application is steadily increasing,
- in the past greater part of the research concentrated on operational aspects and currently is it shifting towards the organisational development and human resource disciplines,
- strategic alignment in all areas of an organisation is hard to reach, if it is done though, it guarantees successful transformation,
- Lean goes beyond manufacturing and service sector, integrating aspects of environmental protection management,
- system thinking in Lean concept is discussed by researchers theoretically and it will be a topic for the future research.

2.2. Six Sigma

Linderman et al. [23] define Six Sigma as a systematic and organized approach to long-term process improvements aligned with the strategy of organisations, both for new product and service development based on statistical methods in addition to scientific method aimed at reducing customer defined defect rates [29].

Bill Smith, an engineer at Motorola, developed Six Sigma in the mid-1980s. The motivation behind the invention was to reduce the high cost of poor quality. The methodology contributed to Motorola's quality turnaround and is believed to be the key factor of winning the 1988 Baldrige National Quality Award. However, the roots of the methodology lie in Deming's TQM principles and the works of Juran [6]. Later, Six Sigma was promoted in General Electrics (GE) both internally and externally as well as in many Fortune 500 companies in the 1990s. It was becoming popular and was gaining advantage over other improvement techniques.

"Sigma" is a statistical term referred to the measurement of process deviation from perfection. The idea behind is to measure the number of defects in the process, to prevent them systematically and to get to "zero defects". Ideally, a process should not exceed 3.4 defects per million opportunities to achieve the exact six sigma quality. Here an "opportunity" is a chance for non-conformance or failing to meet the required specification [30].

Six Sigma is guided by a structured problem solving method, widely known as DMAIC (Define, Measure, Analyse, Improve, and Control), as shown in Fig. 1.

The method highly relies on data analysis and fact-based decision-making [1, 19]. Each stage of the method possesses specific tools and techniques and seeksto reduce variation in processes to gain high quality conformance from the customers' perspective [2, 7].

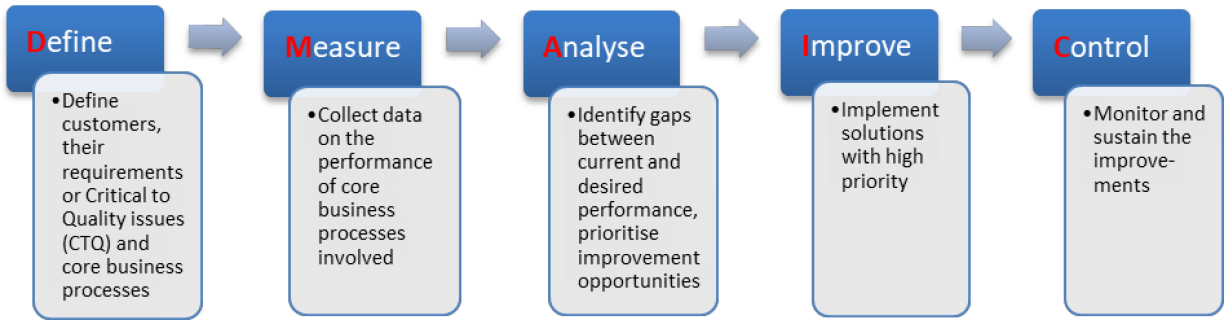

Fig. 1. DMAIC roadmap. Source: Adapted from GE Capital (2012).

2.3. LSS

Lean production and Six Sigma had been used separately for decades before they merged in the late 1990s. George [15] defines LSS as a structured theory based methodology that concentrates on performance improvement, effective leadership development and customer satisfaction. Spector [37] states that LSS is one of the most effective methodologies in the process improvement and it is widely utilised in various top performing organisations.

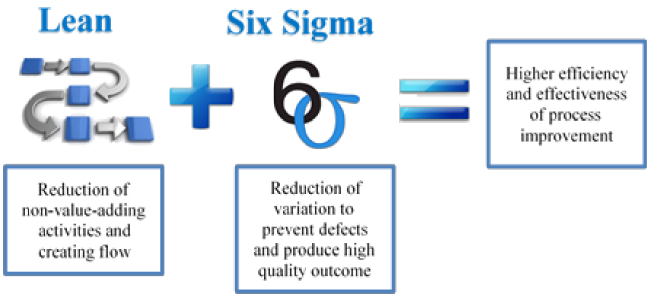

Fig. 2. Lean Six Sigma synergy. Source: Authors view.

Zhang [43] concludes that the combination of lean manufacturing and six sigma produces a greater effect than each one of them seperately and eliminates the cons of each approach in the meantime. The following figure explains the core of LSS.

Behind each building block of LSS, there is an enormous body of knowledge that was developed by researchers and practitioners. However, each organization has to adjust LSS to its specific needs and conditions of business processes.

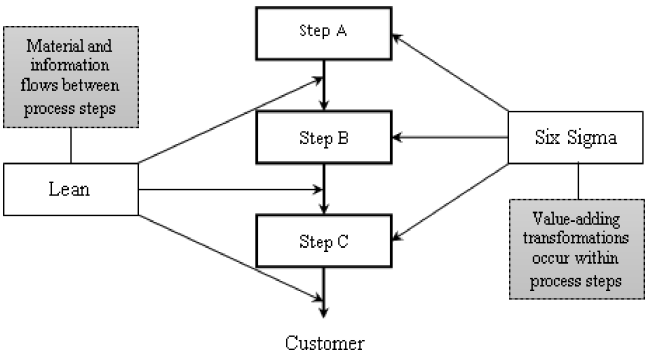

Fig. 3. Opportunities for improvement. Source: Snee [36].

Majority of business processes consists of subprocesses and each of them includes more material and information flows. Snee [36] adds that the flows between process steps consist of non-value adding activities (wastes) that in great extent affect the overall process performance (Fig. 3).

Therefore, the improvement potential of LSS becomes higher than the use of Lean or Six Sigma separately, because LSS pursues higher process efficiency and quality of outputs or effectiveness.

2.4. Success and failure factors of LSS

A great number of companies launch LSS implementation and follow the methodology for a certain period of time. However, the majority of them refuse to continue it for different reasons. A survey conducted by Industry Week revealed that only two percent of firms using Lean achieved their expected goals and about 74 percent did not have any positive progress with Lean [27]. Thus, it becomes important to understand the main reason behind the success and failure of LSS initiatives.

Critical Failure Factors (CFF)

Garg and Garf [13] defined CFFs as key aspects or areas where things could go wrong and cause the failure or an implementation, which fails to achieve a sufficient return on investment (ROI).

Albliwi et al. [3] in their systematic literature review studied journal papers related to Lean, Six Sigma and Lean Six Sigma from 1995 to 2013. As a result, 34 factors leading to deployment failures of LSS were determined out of which the following were cited more frequently by different authors:

- Lack of top management attitude, commitment and involvement.
  This factor applies to all industries where LSS was applied and to various countries and size of organisations. Without it, most of initiatives are likely to fail in the very early stages as well as with a proper management support improvement programmes tend to yield essentials benefits [36].
- Lack of training and education in field of LSS.
  As trainings are expensive, many firms neglect them. However, it is critical for achieving success in LSS. Laureani and Antony [21] explain such behaviour as

lack of long-term vision and absence of an immediate ROI.

- Poor selection and prioritisation of LSS projects.
  Duarte et al. [11] state that selection of an inappropriate project leads to LSS fail as well as termination of LSS implementation in a great number of cases. If a right project is chosen, it guarantees the highest return for the company.
- No linkage of improvement projects to strategy.
  Strategic objectives of companies are to be given the highest possible priority and major resources should be aligned to their achievement. If improvements does not have an effect on strategic objectives, it also tends to fail.
- Lack of technical, human and financial resources.
  All the above mentioned is hardly achievable without a sufficient amount of resources. This problem is inartistic to most companies throughout the world.

According to Albliwi et al. [3], CFF may also depend on the development of countries, where applied, the nature of industry and the size of an organisation. LSS in developing countries tends to fail more often compared to developed countries which have a higher amount of resources and knowledge available. LSS deployment has also to be adjusted depending whether it is applied in services, healthcare, higher education, manufacturing or other sectors.

Deep analysis of CFF enables researchers and practitioners in the field of LSS to transform them into CSF so that to ensure positive results by addressing them. The following sub-chapter covers CSF of LSS and summarises the research in the field.

Critical Success Factors (CSF)

Success factors are the factors which are crucial to the success of any program or technique in such a way that if objectives associated with the factors are not attained the application of the technique will perhaps fail completely [33]. Brady and Allen [6] explained CSFs as the key things that must be achieved by an organisation to identify the areas which will produce the greatest "competitive leverages". They emphasised that CSFs are not the main aims. They are rather the actions and processes that management can control in order to attain the organization's goals [17, 42].

Laureani and Antony [21] conducted a survey of 31 literature sources discussing success factors for LSS implementation from which they found 19 success factors that they later included into a questionnaire. It was used to verify if the organisations that implemented LSS possessed or shared any of those factors, and which ones they considered as more important. Based on more than 101 received responses, the chosen success factors were ranked according to the average importance scores (see Fig. 4).

The results of the survey confirmed that among the success factors for starting the LSS initiative in an organisation are:

- Management commitment
  Without the continuous support and commitment from top management, the true importance of the initiative will be in doubt and the energy behind it will be weakened [26].
- Organisational culture
  A successful introduction and implementation of LSS requires adjustments to the culture of the organization and a change in the attitudes of its employees. LSS initiatives require the right mind-set and attitude of people working within the organization at all levels. The people within the organization must be made aware of the needs for change [4].
- Linkage of LSS to business strategy
  LSS is an improvement-focused approach aimed at developing and improving operational capability, its implementation should be considered strategic, in the sense of following an approach, which deals with a particular business situation or circumstance [24].

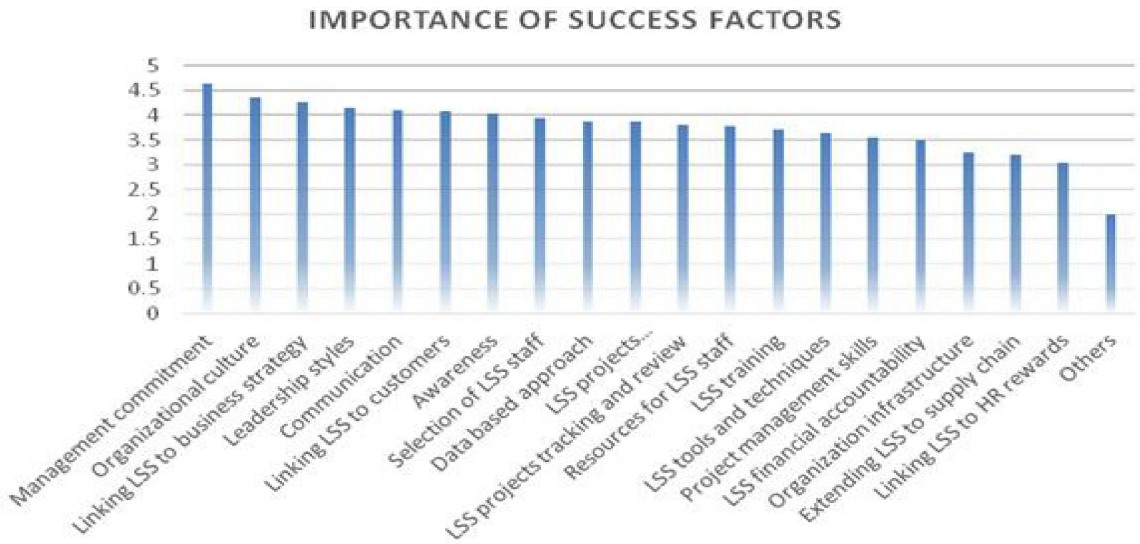

Fig. 4. Success factors average importance score. Source: Antony and Laureani [21].

However, the survey also revealed that there is a difference in the attitudes of the practitioners and scholars towards the Leadership styles factor. In the literature, this factor is mentioned as less important compared to the perception of it by the practitioners in the field.

There are many CSFs in determining the LSS implementation success and each CSF is dependent on each other in order to make the LSS program a success. Although Jeyaraman and Teo [20] suggest that some vital CSFs need to have more focus, the trivial CSFs cannot be ignored absolutely. It is believed that the implementation of the LSS program is very difficult. In order to reap significant improvement on the company performance, it should be properly planned to implement successfully.

Snee [36] argues that LSS does improve particular processes and even overall performance, though to survive and succeed nowadays it is necessary to look beyond LSS. Continuous learning and improvement should be a prerogative of any modern organization willing to generate adequate outcomes [39].

To remain competitive in today's information-saturated and globalized world, it is a must to remain dynamic and to constantly look for possibilities to improve. Even in 1994, Garvin [14] stressed the importance of commitment to learning for the continuous improvement programmes. Change is the only constant we should expect in the workplace, and therefore, we must rid ourselves of traditional, hierarchal organizational structures that are often change-averse, or undergo change only as a reaction to external events.

LO embraces change. LSS is a methodology based on continuous change. Rheem [32] proposed that both LO and LSS help to create workplaces with a better culture that will bring :

- independent thoughts,
- increased ability to manage changes,
- quality improvement,
- expansion beyond the perceived limits.

Senge [35] presented a very clear link between Lean and LO by stating that systems thinking (the fifth discipline) was a key to organizational learning. George [15] thought that if Lean is applied in a proper way, it creates an ability to learn. It was also noted that Lean behavior of employees can be characterized as one overcoming office politics and some other similar wasteful activities. Bowen and Spector [37], commenting on the Toyota Production System (TPS), observed, "the system actually stimulates workers and managers to engage in the kind of experimentation that is widely recognized as the cornerstone of a learning organization. That is what distinguishes Toyota from all the other companies we studied" (p. 97).

One of the forms of explaining Lean is a model called "House of Lean". There are many modifications, but the basic one is presented in Fig. 5.

The base of the house is standardization and stability. Lean methods are the columns that help to achieve and maintain the goal of delivering the highest possible value to the customers based on their expectations depicted by the roof.

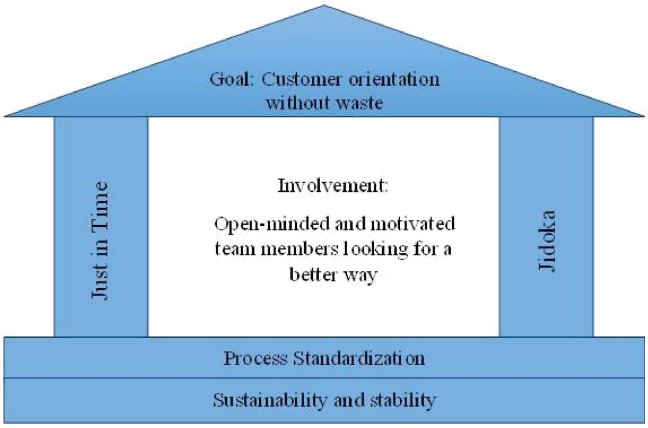

Fig. 5. House of Lean. Source: adapted from Dennis [10].

Francis [12] visualizes the theoretical link between LO and Lean – Fig. 6.

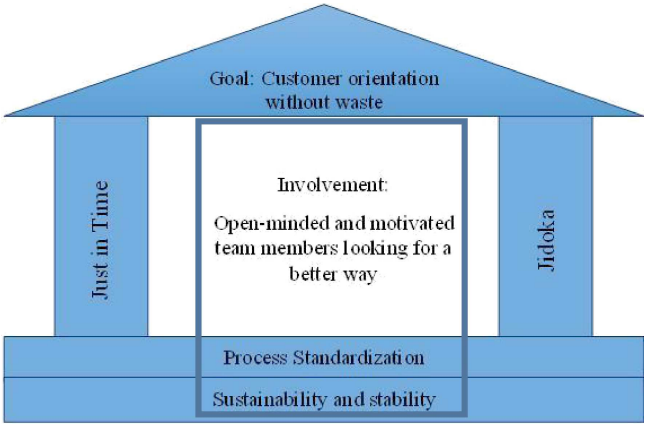

Fig. 6. House of Lean model showing the intersection with the learning organization. Source: Francis [12].

Francis [12] implies that LO is at the heart of any Lean initiative. Stability and Standardization are the integral parts of both concepts. Continuous learning and improvement are interrelated and are of an immense importance to the successful implementation.

The competition keeps getting stronger and companies that do not become learning organisation and do not share LSS philosophy might not survive much longer. They would just be incapable of adjusting fast enough to respond to the dynamically changing world.

3. Conclusion

Last but not the least, the principle of "14 Principles of the Toyota Way" by Liker [22] is "Become a learning organization through relentless reflection and continuous improvement" [28]. No organisation is perfect and it means that there is always some room for improvement. Continuous improvement helps to be better and better and it aids changes and learning in production. Experiments and new ideas might be of little

help if no learning and reflection is drawn out of the results. This is another undeniable fact of an existing similarity between Lean and LO. LSS were integrated at the end of the 20th century and since that time there has been vast amount of its adoption examples by not only manufacturing but also service organisations [9]. However, Bendell [5] claims that these approaches are not really completely compatible and their application might lead to sub-optimal improvement programmes. Some researchers suggest that in order to yield benefits of LSS, it is necessary to create a special culture of change within the organization. And it is believed that this can be achieved via applying principles of LO. Sometimes too much attention is paid to lean tools and it is at the expense of building a culture of continuous improvements or changes connected with increasing learning capability. Despite being used for about 15 years, LSS has not been adequately analysed. Problems arising from LSS introduction and operation still have not been sufficiently researched. Even less research has been conducted in the field of LO. Different industries possess its specifics that could be perceived as obstacles for the implementation and sustainability. Such a fact also necessitates further research in this field. However, LSS and LO concepts have a big impact on production companies.

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