

Applying lean six sigma principles in organizations: The opportunities and barriersCan Biçer¹**Abstract**

This conceptual study initially provides a framework for lean Six Sigma principles in organizations. The research objective of this study is to present the mainlines of lean Six Sigma and to comprehend the perspective of organizational theories and applications of lean Six Sigma (LSS). The pursuit of excellence, LSS, aims to eliminate waste while improving the quality of organizational processes. However, the margin between good times and bad times can usually be thin for the organizations. While the coronavirus pandemic enters its third year and thanks to record-high inflation rates throughout the world, organizations are feeling the sharp price hikes of necessities including transport, energy, and utilities that reducing profits. So, as LSS focuses mainly on removing waste and decreasing the defects and variations in an organization's processes and aims at increasing customer satisfaction productivity, and quality, organizations that employ LSS principles in their operations will be more ready to react to unforeseen events or conditions which may jeopardize organizational structure and outcomes. In sum, this study aims to draw a framework on LSS and its key effects on organizations and to uncover a detailed review of LSS thinking and the opportunities and barriers to implementation of LSS in organizations.


Key Words: Lean Management, Six Sigma, Lean Six Sigma

JEL Codes: M11, M12, M13

1. Introduction

In today's dynamic, fast-moving business world, organizations strive to reach their goals and true potential while operating in an environment determined by a fast pace, volatility, and uncertainty as technology has developed at an exponential rate and has changed every aspect of the way any organization operates, which has never occurred so fast before in history. Therefore, as highly stiff global competition forces organizations to improve their functionality and processes to gain competitive advantages, organizations have begun to search for decreasing costs while increasing their functionality, speed, and flexibility in today's customer-driven competitive economic landscape. Because, it's obvious that organizations are only kept alive by their customers and their ever-changing needs, and they can only maintain their activities with the help of customer satisfaction. Therefore, consistent, fast change is the essential agenda for the difficulties that organizations and their management team confront in the 2020s. Accordingly, the LSS, which focuses mainly on defining the ever-changing customer needs and wishes, eliminating all non-value-added activities, and reducing the variability within the production process in organizations, has appeared to be one of the most efficient management styles in today's volatile, dynamic economic environment.

Initially, LSS is the cooperative energies of the Lean and Six Sigma, which are important business techniques to improve the quality and productivity of organizations and LSS is a basic approach that is used to recognize and dispense with defects and failures in business by zeroing on process execution attributes that are extremely basic to quality (Singh and Rathi, 2019: 622). Additionally, LSS is a management method that depends on a collaborative team effort to improve organizational performance by systematically removing waste and reducing variation in operations. To eliminate the various kinds of waste in organizations, it combines lean manufacturing/lean enterprise and Six Sigma (Drohomeretski et al., 2014: 804). LSS drives customer satisfaction and primary concern results by lessening variation, waste, and process duration, while advancing the utilization of work normalization and stream, accordingly, making an upper hand. It applies to any place variety and waste exists, and each representative ought to be involved. Hence, the successor of LSS, Six Sigma originated from the U.S. company, Motorola in 1986 and it is commonly believed that Six Sigma was first developed within

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Motorola in response to the kaizen, lean manufacturing, first developed as a business model in Japan. (Mohapatra et al., 2021:641).

In sum, LSS is a unification of two well-known process improvement methods, Lean and Six Sigma, which seek operational excellence for organizations and the lean concept originates from TPS – Toyota Production system, which is also called “just-in-time production”, “JIT, depends on working intelligently and eliminating waste. And LSS enables organizations to improve their performance by improving quality, reducing cycle time, along with creating value for customers and stakeholders at all levels of the organizations it also assists organizations to meet and exceed customer needs in a fast-changing and competitive global environment. In conclusion, this conceptual study aims to present a framework of strategy, the concept, and application of LSS in organizations and it contributes principally to identifying the main characteristics of the LSS and its organizational implementations, and the purpose of this paper is also to review (LSS) literature, report definitions and compile the list of opportunities and barriers in implementing LSS in organizations.

2. Six Sigma, Lean Six Sigma

In this section, the developmental background of the two major philosophies for the business world, Six Sigma, and LSS will be outlined in detail.

2.1. Background of Six Sigma

Today, Six Sigma (6σ), which is a set of techniques and tools for process improvement, has a noteworthy history of further developing organizational processes with its wide cluster of instruments and strategies. Sigma Belts - people who are educated in some or all parts of Six Sigma - are profoundly requested by organizations searching for individuals to further develop their business performance. As Brue stated (2015), the creation of Six Sigma can be related to Carl Friedrich Gauss (1777–1855), regarded as one of the most influential mathematicians in history. Gauss introduced the concept of the normal curve, or normal distribution, also known as the Gaussian distribution or Gaussian curve. The major base of a statistical hypothesis, as used in Six Sigma, is German mathematician Friedrich Gauss' Normal Distribution curve (also called a Bell Curve). The exceptions on the ordinary dispersion lie products of one standard deviation, addressed by the Greek letter set ' σ ' ('sigma'), away from the mean. With regards to factual quality control, processes and products are measured and assessed to decide variety from adequate guidelines, and the spread of the dissemination implies variability.

Initially, the Six Sigma methodology, which has been commonly used in businesses, is often regarded as the ultimate version of Total Quality Management (TQM) and fast-forwarding to the year 1985, the beginnings of Six Sigma were underway at Motorola. The evolution of Six Sigma began in 1985 with a memo from then Motorola quality engineer Bill Smith to then Motorola CEO Bob Galvin. The memo, noted by Smith, statistically indicated the relationship between product field life and how much rework occurred in the production process. In 1986, Bill Smith, a senior engineer and researcher inside Motorola's Communications Division, presented the idea of Six Sigma because of expanding grievances from the field deals force about guaranteed claims. It was another technique for normalizing how imperfections are counted, with Six Sigma being close to perfection. Smith made the first measurements and equations that were the beginnings of Motorola's Six Sigma philosophy. He took his plans to President Bob Galvin, who was struck by Smith's enthusiasm and came to perceive the methodology as key to tending to quality worries. Six Sigma became key to Motorola's system of delivering products that were good for use by customers (Hallam et al., 2010: 4; Barney, 2002: 13).

From the historical point of view, Hernandez et al. (2021) underlined that lean management originates from the lean manufacturing thinking, which was derived from TQM, which focuses on effective control of business processes and customer satisfaction, and is commonly regarded as one of the former interpretations of 'Six Sigma'. Through the years, 'Six Sigma' has been considered an effective management tool that has been proved to be one of the best ways of instituting change, reducing errors, and eliminating waste and inefficiencies in organizations. The main principles of Six Sigma focus on

the whole spectrum of organizational operations, from facing serious problems to daily organizational operations. And, the term ‘Six Sigma’ is a derivation of the normal distribution utilized in statistics that refers to the customer-based tolerances for acceptable output which are six standard deviations from the mean. Hence, outputs (services or products) may vary slightly in size, shape, look, feel, or any other measurable characteristics while measuring processes in organizations and this variability is measured by a statistic called the ‘standard deviation.’ In addition, Costa et al. (2018) maintained in their study that Six Sigma is a management philosophy for organizational improvement, and Sigma, σ , is a letter in the Greek alphabet used by statisticians to measure the variability in any process. The name Six Sigma refers to a goal of 3.4 defects per million opportunities and Six Sigma aims to detect and eliminate reasons for mistakes or defects in organizational processes by focusing on outputs that are of critical importance to customers. An essential element for the achievement of the Six Sigma management principle is the step-by-step approach or roadmap for improvement, define, measure, analyze, improve, and control (DMAIC) methodology. DMAIC arranges the use of a huge scope of instruments during Six Sigma projects. The DMAIC method in Six Sigma is usually defined as an approach for problem-solving and Six Sigma heavily depends on causal modeling, in which a process’s Critical-to-Quality (CTQ) characteristics are considered as the outcomes of causal influence factors (the Xs). Figure 1. displays the functions of the DMAIC stages and their steps and prescribed actions reconstructed:

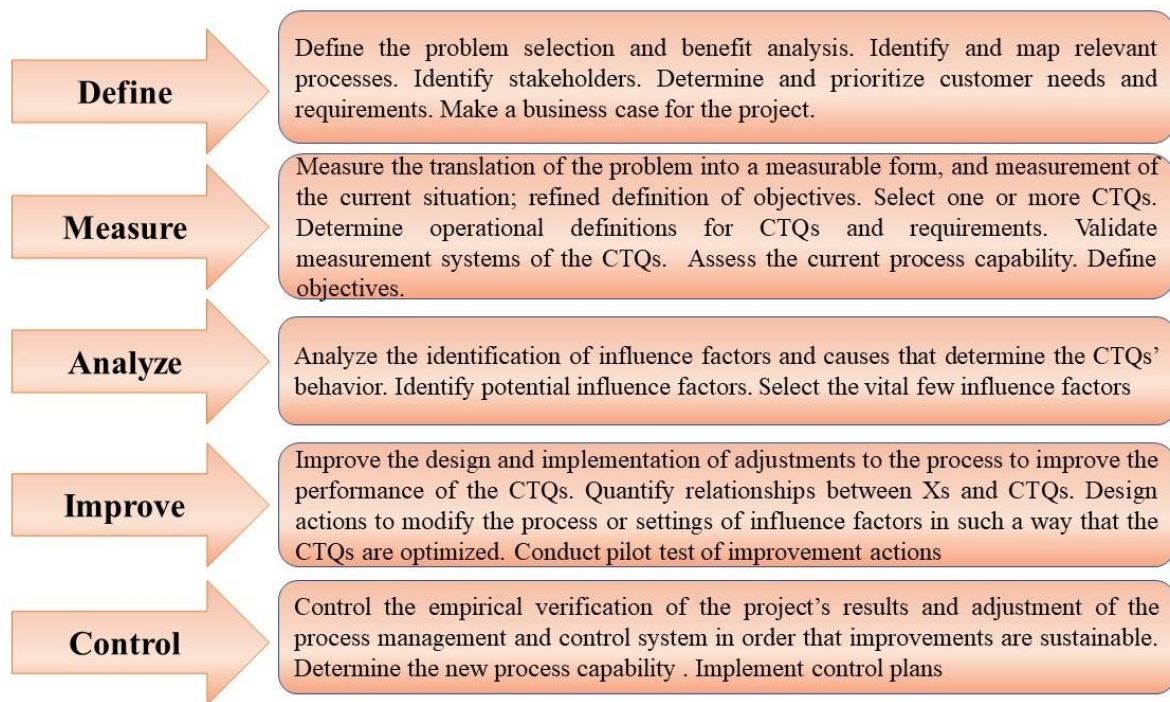


Figure 1. The stages and steps and functions of the DMAIC

Source: De Mast, J., & Lokkerbol, J. (2012). An analysis of the Six Sigma DMAIC method from the perspective of problem solving. *International Journal of Production Economics*, 139(2), 604-614. p.605.

In sum, as global competition has become more and more fierce and customers’ demands change fast and expect higher quality at lower prices, organizations’ profit margins seem to be shrinking especially in times of crisis and unprecedented events, such as the Covid 19 pandemic. Therefore, an efficient and effective strategy and newer management method, Six Sigma has been employed by numerous companies. According to Singh and Rathi (2019), Six Sigma has had the greatest beginning when it was launched by General Electric (GE) in 1995, and many other organizations such as Dow Chemical, 3M, Maersk, Caterpillar Inc., Ford Motor Company, Boeing, Du Pont, and American Express began utilizing Six Sigma for further improvement and exploring their business in between 1990 and 2000 and United States Army has also applied Six Sigma principles for improving quality.

2.2. Background of Lean Six Sigma

The lean method depends on Toyota’s production system, and lean management, dating back to the late 1940s, Toyota first employed lean manufacturing principles, whose goal was to reduce the processes that did not add value to the end product. Thus, supervisors had been able to accomplish significant improvements within the concept of productivity, efficiency, cycle time, and profitability. It is also a well-known management and work organization method which depends on improving an organization’s performance and, especially, the quality and profitability of organizational outputs. Firstly, Six Sigma first became popular in the late 1990s by the General Electric Corporation and their former CEO, Jack Welch. Also, lean management is a methodology that focuses on reducing cycle time and waste in processes. Lean management essentially originated from the Toyota Motor Corporation as the Toyota production system (TPS) and increased in popularity after the 1973 energy crisis. The notion of lean thinking (LT) was created from the Toyota Production System (TPS), which includes deciding the worth of any interaction by distinguishing valued-added activities or steps from non-value-added activities or steps and dispensing with waste so that each progression increases the value of the process. The term “lean thinking” was coined by James P. Womack and Daniel T. Jones in their book lean thinking. The term LSS, which was first presented in literature around 2000, was developed in 2003 as part of the evolution of Six Sigma (Antony et al., 2017: 1073-1075).

Moreover, Ruban and Asokan (2018) emphasized in their study that lean manufacturing, which has been inspired by Toyota’s production system (TPS), highlights consistent elimination of wastes while expanding capacity and diminishing inventory through reducing the system variations in organizations. Also, this strategy boosts customer value while limiting waste via lean operations. It has also been mentioned that today’s manufacturing companies usually employ both lean and six sigma strategies to facilitate waste elimination and defect reduction by deploying the combined power of Lean and Six Sigma concepts since the 1990s. Because, Lean and Six Sigma strategies have often been chosen to increase velocity, eliminate waste, and minimize process variation, and LSS principles not only assist in defining major variables inducing process variation but also assist in optimizing those variables effectively in organizations. Figure 2 displays the historical evolution of LSS:

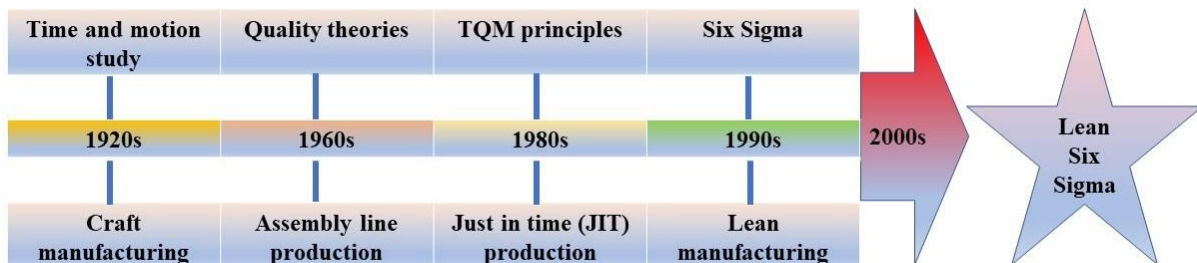


Figure 2. The Historical Evolution of LSS

Source: Ruben, R. B., Vinodh, S., & Asokan, P. (2018). Lean Six Sigma with environmental focus: review and framework. *The International Journal of Advanced Manufacturing Technology*, 94(9), 4023-4037. p. 4024.

Likewise, Maleyeff et al. (2012) emphasized in their study that expecting the future directions of worldwide organizational operations will be basic to the proceeded with the importance of LSS as an instrument to further develop business performance. The projected business management trends that LSS specialists ought to be worried about maintainable strategic approaches, the development of worldwide business markets, mechanical advancement, global guidelines, and knowledge of employee performance management. Inside these unique circumstances, a predominant trademark will be volatility. Furthermore, it is essential to take note that the traditional implementation of LSS to producing activities will remain because of developing markets for produced products and expansions in global labor rates. And it has been underlined that an organization’s capacity to be sustainable will be a vital element in determining its success during this new century since specific technological advances such as e-commerce, virtual teams, and artificial intelligence will make the leaders’ duties

more complex, and the fast technological changes will surely cause smaller product life cycles with little time to supply research and improvement costs.

In conclusion, Parmar and Desai (2019) claimed that the objective of sustainable improvement should be to level the financial, ecological, and societal demands, allowing wealth for present and next generations, the benefits of LSS principles for the environmental waste reduction and sustainability, and combining lean, and Six Sigma for the organizational process within the concept of hereinafter. It has also been argued that the proposed structure based on the possible merger of these approaches and defining the drivers, barriers, and essential performance measures of vital factors of Green Lean Six Sigma (GLSS) is likely to happen in the future. In addition to this, Alduraibi et al. (2021) claimed in their study that three phrases that they are dealing with the major goals of today's organizations are information management, Six Sigma, and sustainable development, and the higher capability of Six Sigma concepts will drive organizations sustainability greatly and the three dimensions of Six Sigma that are required to achieve a state of sustainability and consistent improvements are strategic, tactical, and operational dimensions. It has been claimed that, in the future, organizations will combine and implement the GLSS methods to improve their sustainability performance. And, it has also been asserted that the organizations which employ Lean, Six Sigma and Green principles will certainly experience reduction in their resource consumption from 20% to 40%, and minimization the cost of energy and mass streams by 7–12% and so, they will improve process flow, increase customer satisfaction and improve the bottom-line results too.

3. Insights into Aspects of Lean Six Sigma Principles in Organizations: The Opportunities and Barriers

In this section, the opportunities and barriers in implementing LSS thinking in organizations will be outlined in order to fill the research gap in the literature by highlighting various definitions from different researchers.

At first, organizational operations may be successful, employees may be performing at their best, however, today, keeping the edge is the key because the margin between good times and bad times can often be thin due to economic uncertainties and risks that jeopardize the organizations' roles and plans on the whole. For example, The COVID-19 pandemic, which began to spread globally in the late 2020s, has created a crisis unprecedented in terms of and social, economic damages throughout the world. Moreover, crises sometimes cannot be avoided or be managed easily, but their effects can be minimized by employing effective management techniques. Managing cost has turned into the greatest challenge for any organization in economic crisis circumstances and the actions they take to deal with is exceptionally critical to the business in both short term and long haul. Rather than been cautious and taking unnecessary cost reductions, it is generally prudent to recognize the causes of non-value-adding exercises to the business processes and attempt to erase them. Lean Six Sigma is the best methodology for this, and organizations have a generally excellent possibility of flourishing even in totally troublesome circumstances. Therefore, as LSS thinking is mainly about training to solve small crises – problems it surely helps organizations solve not only the big ones like coronavirus, which test the limits of any organization's sustainability but also smaller crises that appear as part of any business operation every single day. For example, Galli (2018) emphasized that besides organizations' ultimate goals are about making more profit and increasing their market share, organizations urge to make their processes more efficient and less variable and to increase process efficiency, so they usually implement Lean Six Sigma to be more prepared for crises. Also, Sunder et al., (2020) maintained that lean joined with Six Sigma makes cooperative energies for organizational process improvements and LSS conveys preferred outcomes over lean or Six Sigma applied in isolation. And, it has also been asserted that Six Sigma lacking lean will just include a number of tools for improvement, however, having no strategy or structure to drive the organizational system, and lean thinking lacking Six Sigma comes up lacking a structure for process improvements. It has been underlined that LSS gives a dynamic upper hand to organizations by bringing down costs and further improving value. Being a hybrid procedure, LSS beats the inadequacies of lean methodology by additionally lessening process variations and defects,

prompting higher customers' satisfaction and primary concern advantages to organizations. Once more, Sa et al. (2022) also asserted in their study that LSS not only reduces waste with six sigma instruments and techniques to achieve zero variation but also it promotes learning and knowledge creation in the organization and improves working conditions as well. Hence, Figure 3. shows the main benefits of LSS for organizations:



Figure 3. 5 Major Benefits of LSS

Source: Sá, J. C., Vaz, S., Carvalho, O., Lima, V., Morgado, L., Fonseca, L., ... & Santos, G. (2022). A model of integration ISO 9001 with Lean six sigma and main benefits achieved. *Total Quality Management & Business Excellence*, 33(1-2), 218-242. pp.222-225. Swarnakar, V., & Singh, A. R. (2021). Assessing benefits of Lean Six Sigma approach in manufacturing industries: an Indian context. In *Operations Management and Systems Engineering* (pp. 127-144). Springer, Singapore.p.128-130.

According to Fernandez-Solis and Gadhok (2018), LSS strategy in business management mainly focuses on both high-cost savings and variability reduction and also on identifying and systematically removing the defects and waste from every process within an organization. Also, it has been outlined by Antony et al. (2019) that LSS creates opportunities for organizations such as:

- Freeing up staff for high value tasks,
- Reduced operational risk,
- Reduced variability in output performance,
- Improved customer experience,
- Increased output.

On the other hand, Gaikwad et al. (2020) emphasized that the advantages of LSS are prestigious and well-known; nevertheless, a few elements can lead LSS application in organizations to come up short in various areas, including small and medium-sized enterprises (SMEs). A common perception is that the LSS technique is just applied by organizations with great turnover numbers and a lot of individuals. Nonetheless, it is a misconception judgment among industrialists that LSS is just for bigger organizations and not so much for SMEs. With proper techniques, strategies and administrative help, LSS can be embraced superfluous of the size of the organization. Notwithstanding, SMEs face a few difficulties in carrying out LSS that make snags to utilizing the advantages. Besides, the difficulties looked by SMEs are not the same as those of enormous organizations for quite a long time, like contrasts in the size of tasks and accessible assets. In addition, according to Rathi et al. 2022 LSS application isn't always a smooth endeavor. And, for example, the deficiency of physical and technical specifications, trade and instruction, as a critical part of Six Sigma implementation in the UK, which is principally

existed in medium and small businesses have been mentioned. Moreover, a lack of know-how and resources, no perceivable advantages, and the customer's reluctance to pay for the activity as the essential impediment to an accomplished execution have been outlined. Figure 4 displays the barriers mainly reported in implementation process of LSS in organizations:



Figure 4. Major Barriers of LSS Implementation in Organizations

Source: Yadav, G., Seth, D., & Desai, T. N. (2018). Prioritising solutions for Lean Six Sigma adoption barriers through fuzzy AHP-modified TOPSIS framework. *International Journal of Lean Six Sigma*. P.1169. Rathi, R., Singh, M., Verma, A. K., Gurjar, R. S., Singh, A., & Samantha, B. (2022). Identification of Lean Six Sigma barriers in automobile part manufacturing industry. *Materials Today: Proceedings*, 50, 728-735. P.731.

Furthermore, Marolla et al. (2021) pointed out that during the implementation of LSS, several suboptimal results or frustrating failures have been occurred since critical failure factors or barriers and obstacles in organizations were not adequately defined before. Hence, it has been underlined that the failures were mainly due to an inappropriate combination between Lean and Six Sigma. However, it has also been mentioned that the success indicator of implementing LSS shouldn't be considered as any financial improvement and cost reduction in organizations solely, besides, the achievement of LSS application must also be measured on a foundation of non-financial and nonperformance basis such as an enhanced working environment, improved employee morale, cross fertilization of staff, cross-functional teamwork, and the transformation of the organizational culture from reactive to proactive state. Indeed, as Mughal et al. (2020) stated, many manufacturing and automotive companies, some of SMEs, food and construction firms have implemented LSS in the world. It has also been underlined that lots of organizations, especially in developing countries, are reluctant to employ LSS principles because of resistance from employees and top management due to the lack of awareness about the effectiveness and impact of LSS thinking.

However, Stankalla et al. (2018) have mentioned the important role of the critical success factors, which are mainly dealt with clear organizational objectives, optimization and meeting customer needs, in implementing the LSS successfully in organizations and it has been underlined that if any of the critical success factors are overlooked or missing through the development and implementation stages of a LSS process, it might lead to serious negative outcomes for the organization and it might jeopardize the organizational long-term success. To sum up, as Sreedharan et al. (2018) argued, LSS is a contemporary continuous improvement approach for quality improvement that has been ended up finding actual success across production as well as services. LSS is not only simply a continuous improvement technique yet a business strategy that upgrades process performance by further developing key performance indicators, but also its affects improved bottom-line results positively. It has also been argued that if LSS, which combines the tools and principles of both lean and Six Sigma to get the synergetic-best of the two ideas, is deployed successfully to the organizational operations, then it will surely develop speed while delivering organizational quality output. Because this combination permits the organizations to consolidate the organized critical thinking ability or structured problem-solving capability as a component of the organization's culture.

4. Conclusion

The purpose of this paper is to review the historical development of LSS and to identify the major opportunities and barriers for the application of LSS within organizations. Indeed, as LSS continues to gain popularity and acceptance in business management in today's ever changing economic and business world, this conceptual paper provides a detailed framework on how LSS can be applied successfully in organizational and managerial operations as well. Also, this study will prove to be a fundamental resource for researchers and practitioners who are engaged in research and applications of LSS.

Organizations throughout the world usually try to be more competitive and work efficient though they face lots of uncertainties of varying consequences which are especially caused by financial and social unprecedented events or outcomes. Also, traditional management operating methods hardly ever do well at such times, for example, Covid 19 pandemic or during financial crises, and organizations which deploy incompetent managerial methods and thinking will surely find themselves facing existential threats. Moreover, leaders should be aware of the risks that a highly uncertain environment brings, and managerial team is prepared when challenges arise by relying on the capability to act collectively, quickly and flexibility. For example, since uncertainty may reach at extreme levels, organizations should have adopted more adaptive management skills and agile techniques to make planning more flexible and responsive to sudden, unprecedented outcomes. Therefore, in today's challenging economy, LSS will be the key as it mainly focuses on improving goods and services they provide, reducing budgets and rising costs though there is limited time for training and process improvement and doing more organizational daily operations with less. Hence, Fletcher (2018) also stated that as LSS is the implementation of lean strategies to speed up and lessen burn through and doing things right the initial

time, doing things that create value and doing it all proficiently it acts toward difficulties with a receptive outlook as arrangements can emerge out of unlikely sources especially during crises periods.

The business world is changing rapidly, so the customer expectations, and whether it is driven by technology, globalization or in response to specific crises, it's obvious that the business world of today must constantly adapt to ongoing changes and improvements to remain efficient and competitive. And as the role of the management team in organizations is evolving too, newer management methods should involve open minded and flexible thinking, value-added agile technical, organizational, business skills, adaptability, critical thinking, and effective communication. Additionally, Gleeson et al. (2019) highlighted the major factors in LSS such as creating a clear standard of quality which is defined by what the customers or changing market demands and the best way to ensure it is the feedback and efficient communication, and it has been underlined that feedback is essential on expertise development and if the transparent feedback system is enabled in organizations, then its organizational operations will be enhanced. Other factors are being flexible and responsive which are dealt with the principles of LSS and since the change and change management can be challenging, a leaner, stronger and more competitive organization can only be created with the thinking of LSS as it focuses on removing variation and bottlenecks.

In short, there are various barriers to overcome such as poor participation of employee, lack of training and knowledge, internal resistance, lack of resources, lack of executive commitment, poor training and poor six sigma project selection and if LSS strategies are implemented properly to improve organizational effectiveness then plenty of opportunities will be created dealing with financial, employee and customer benefits. In conclusion, beyond focusing on business process improvement, total overall quality management, strategy implementation for better results and leadership development, LSS not only provides variation reduction and increases value in organizational operations, but it also creates more value for customers by solving critical quality issues which have impact on harmony and renewability in a product and process in organizations. Because it's very important for organizations, first to survive and then to improve themselves that what their customers feel about their products or services when comparing them to their competitor's products and services, so as Tyagi (2020) cited famous management guru Peter Drucker's words, "The purpose of business is to create and keep a customer", customers are usually satisfied when the organizations meet all their needs and expectations, so it's obvious that organizations which are deploying management methods that lack customer focus will surely face failures in today's business world.

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ETİK VE BİLİMSEL İLKELER SORUMLULUK BEYANI

Bu çalışmanın tüm hazırlanma süreçlerinde etik kurallara ve bilimsel atıf gösterme ilkelerine riayet edildiğini yazar(lar) beyan eder. Aksi bir durumun tespiti halinde Business, Economics and Management Research Journal'ın hiçbir sorumluluğu olmayıp, tüm sorumluluk makale yazar(lar)ına aittir. Bu çalışma etik kurul izni gerektiren çalışma grubunda yer almamaktadır.

ARAŞTIRMACILARIN MAKALEYE KATKI ORANI BEYANI

1. Yazar katkı oranı: % 100