

# QUALITY ASSESSMENT AND IMPROVEMENT IN HEALTHCARE THROUGH LEAN SIX SIGMA

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Implementation of Lean Six Sigma has become common practice in many levels of business, and it produces efficient and positive outcomes. Over the past two decades, many healthcare systems have been adopting adequate business strategies and implementing them into their respective healthcare facilities. While common and effective for most other industries, Lean Six Sigma has only recently taken over healthcare. Lean Six Sigma has remarkably amended the healthcare system by improving the quality of care for patients and providing healthcare facilities with several cost-effective solutions. Examples of implementing Lean Six Sigma on an entire healthcare system as well as on a departmental level are highlighted in this paper.

## Introduction

LEAN Six Sigma, from its conception, has most commonly been seen in the manufacturing industry. Within the last twenty years or so, we have seen it put into practice in other sectors. Specifically, it has been offering substantial benefits to healthcare facilities that consist mainly of healthcare providers and receivers (Aboelmagd, 2015). Healthcare systems are constructed of a complex service delivery system in order to facilitate the delivery of care to patients. Effectively executing of all the processes and easing the complexity behind them require the involvement of several stake-

holders, or anyone with an invested interest that contributes to the processing of the system (Vest & Gamm, 2009). Implementation of Lean Six Sigma in the healthcare service delivery system aims to achieve high quality data by reducing medical errors. This aids in achieving effective outcomes by increasing patient safety and generating advanced quality of care for patients and healthcare providers.

The healthcare service delivery system is constantly under immense pressure to produce positive outcomes that are efficient and effective for patients. This pressure exists because of globally

increasing financial crises, growing populations, continuously advancing technology, and amending operational

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The American Society for Quality (ASQ) encourages the use of Lean Six Sigma and elaborates on its ef-

fectiveness, stating, management (Stumpf, 2012). Successful outcomes achieved from the implementation of Lean Six Sigma in the health care system can clearly be seen in the areas of medicine diagnostics, laboratory sciences, clinical medicine, and administration (Vendrame Takao et al., 2017). It works to reduce and eliminate medical and administrative errors, as well as to disregard waste created during and after clinical medicine and administrative record keeping.

fectiveness, stating,

Lean Six Sigma is a fact-based, data-driven philosophy of improvement that values defect prevention over defect detection. It drives customer satisfaction and bottom-line results by reducing variation, waste, and cycle time, while promoting the use of work standardization and flow, thereby creating a competitive advantage. It applies anywhere variation and waste exist, and every employee should be involved. (Kubiak & Benbow, 2016, as cited in ASQ, 2012)

Lean Six Sigma is an enhancement concept introduced by Motorola engineers in the late 1980s that focuses on the management within a pre-existing or new system. Lean Six Sigma minimizes errors that occur in a process and maximizes the involvement of stakeholders (Ha et al., 2016). It originated from the theories of manufacturing industries but was eventually implemented in the healthcare service delivery system around the year 2000 as an innovative mechanism to enhance management criteria for the departments of finances, logistics, and administration (Amaratunga & Dobranowski, 2016). The aim of incorporating Lean Six Sigma into healthcare was to achieve an effective way to reduce cost, improve service delivery duration, introduce methods to receive efficient qualitative changes, and increase patient satisfaction (DiPiero, 2016). Lean Six Sigma is considered productive and effective because it joins the technological advancements, equipment, and all the individuals involved in successful functioning of a process.

Lean Six Sigma combines the approaches of two theories common in the manufacturing industry, “Lean” and “Six Sigma.” The Lean principles help to reduce or eliminate the waste produced in the targeted process of a system (Amaratunga & Dobranowski, 2016). The practices under Lean principles incorporate physical and behavioral changes to minimize waste production, which occurs in all steps of the process (Kovach & Borikar, 2018). Therefore, incorporating waste management techniques reduces waste production at each level of the process cycle. The Six Sigma principles focus on supporting the targeted process by measuring its effectiveness and efficiency, while improving quality for the process’s stakeholders (Stumpf, 2012). Six Sigma is an approach to minimize steps in a process in order to reduce complications and shorten the total time of the process (Glasgow et al., 2010). Paired together, these processes become Lean Six Sigma. Together, they result in minimized processing time, increased satisfaction of

**Two Manufacturing Theories: Lean and Six Sigma**

customers/clients, increased efficiency and effectiveness, and improved financial outcomes through increased profits and specified budgets. Overall, these amendments improve the quality of a pre-existing system by incorporating variations in every step of the process.

As just described, Lean Six Sigma is actually the combination of two management techniques that work in tandem

to reduce waste and improve quality. Based on the Toyota production line model that centers around continuous improvement, Lean is a set of principles focused on reducing waste, whether that be in the form of patient wait times or administrative functions related to patient care (Lawal et al., 2014). The methods developed by the Toyota production processes are strongly rooted in the Japanese kaizen model, which is the origin of continuous improvement. The kai-

zen model allows employees on all levels of a process to provide input and make incremental improvements. Implementation of Lean concepts aims to change the thinking and perspective of an organization in order to provide long-lasting improvements to a process and the organization's culture (Lawal et al., 2014). As described in the McLaughlin text (2012), the approach that Lean uses to reduce waste is based on the kaizen philosophy and uses the following steps:

1. **Specify value:** Identify activities that provide value from the customer's perspective
2. **Map and improve the value stream:** Determine the sequence of activities or the current state

of the process and the desired future state. Eliminate non-value-added steps and other waste

3. **Flow:** Enable the process to flow as smoothly and quickly as possible
4. **Pull:** Enable the customer to pull products or services
5. **Perfection:** Repeat the cycle to ensure a focus on continuous improvement (pp. 300-301)

**Successfully removing all the artificial variance, continuously reducing waste, and focusing on creating value for customers is the ultimate outcome of an effective Lean Six Sigma system.**

With Lean also comes some effective implementation tools that aid in defining and understanding processes to be corrected. A few of these that are useful in the healthcare setting include stream mapping, takt time, and standardized work. Stream mapping is used to define the process and determine where waste is occurring (McLaughlin & Olson, 2012). Takt time measures the time needed for the process based on customer demand and can

be used to synchronize flow in a process. This measurement is represented by available time divided by demand (McLaughlin & Olson, 2012). Standardized work is a way to ensure things are done efficiently and that outcomes are consistent; this could include written documentation describing the way in which every step of a process should be performed (McLaughlin & Olson, 2012).

Six Sigma is best used when the goal of a process improvement project is to improve quality and reduce the variability in outcomes (McLaughlin & Olson, 2012). Six Sigma ensures quality through an ongoing measurement of process output characteristics known as "statistical process control," which help

identify problem situations before an error occurs (McLaughlin & Olson, 2012, p. 215). This includes measuring process capability, which determines whether a process is actually capable of producing the desired output, and then benchmarking it against similar processes in other organizations. The primary function of Six Sigma is to eliminate sources of variance in processes and systems, whether it be natural variance or artificial variance (McLaughlin & Olson, 2012). Six Sigma interventions identify, eliminate, and remove those sources of artificial variance that can be changed by people within the system. Six Sigma is focused on making a process effective within a range of 99.99966 % defect-free (Niñerola et al., 2019, p. 1). Combing the methods of Lean and Six Sigma leads to lower rates of error in a production cycle, estimated in the United States to be an astonishing 3.4 defects per million operational activities (McLaughlin & Olson, 2012, p. 221). Successfully removing all the artificial variance, continuously reducing waste, and focusing on creating value for customers is the ultimate outcome of an effective Lean Six Sigma system (McLaughlin & Olson, 2012).

### **DMAIC Framework**

The DMAIC method (Define, Measure, Analyze, Improve, Control) of Lean Six Sigma focuses on improving existing processes but can be applied to new processes as well. The DMAIC problem-solving process, and its derivatives like DMAIIC, follow a five-stage design (Vendrame Takao et al., 2017, pp. 2-3):

1. **Define:** Defining production problems within the context of healthcare is important to implementing Lean Six Sigma. Appropriate incorporation of Lean Six Sigma facilitates the ability of healthcare managers and professionals to identify a problem,

define it, and describe the objectives that need to be achieved in addressing it. Development of a process map prior to the incorporation of a Lean Six Sigma process allows for an organization to clearly understand and describe the process they are trying to correct. As explained in the McLaughlin text (2012), a process that cannot be defined or mapped cannot be understood or corrected. Effectively defining a process supports implementing changes. If the process to be improved were reducing waiting time for patients, a clear definition would provide a baseline so that further steps can be taken. For example, advancing software to automatically update health records or improving access to health insurance information could be implemented and tested for effectiveness.

2. **Measure:** The measurement step checks the effectiveness of pre-existing data gathering techniques and the processing time in each stage of the process. Measurement also aids in locating any bottlenecks, or points where the process is slowing, where actions are required. Processing data that are gathered and issued within the healthcare system are analyzed in the next step.
3. **Analyze:** Data analysis is part of every processing tool. Analysis is where the data collected in each step of the production cycle is evaluated, and elements that need to be eliminated or streamlined in order to improve the process are identified. Lean Six Sigma analyzes data that the manager collected in previous

steps of this cycle and then targets the elements that are preventing effective completion of the production cycle. This methodology ensures that all these issues are highlighted and eliminated during the implementation of Lean Six Sigma. In-depth analysis also identifies and eliminates the root cause of bottlenecks from the production cycle. It is a complex procedure and requires thorough investigation by the managers of a given organization. Tools of data analysis derived from the Six Sigma process include fishbone (Ishikawa) diagrams, check sheets, histograms, Pareto charts, flowcharts, scatter plots, and run charts (McLaughlin & Olson, 2012).

4. **Improve:** After measuring and analyzing problems that arise in the healthcare delivery system, Lean Six Sigma helps develop suitable solutions. Managing emergencies or time-sensitive issues within a system is based on priority. Process simulations can be run before permanent improvement steps are taken, which is less expensive and time-saving. Simulations create and run through hypothetical scenarios to evaluate what-if situations. This method is sometimes preferred as it does not change the real system while still evaluating the effects of implementing amendments (McLaughlin & Olson, 2012). This method of process improvement can be greatly valuable to organizations uninterested in implementing changes with no known benefits. A simulation includes prototyping the solution for the target-

ed healthcare delivery problem and the amendments required to improve it. Assessments at this stage provide evidence for the effectiveness of the solution in place.

5. **Control:** The final step aims to ensure the procedure stays on course by continually monitoring and recording each improvement following its implementation. This step of the Lean Six Sigma methodology supports the real-time implementation of proper tools and application within the system. It holds managers and the organization accountable for ensuring the targeted problem does not reappear. Lean Six Sigma encourages managers to keep continuous documentation of each step of the cycle. This documentation is usually compiled into control charts that track the effectiveness of the new process over time. The implemented change and chances of reoccurrence of the problem are subsequently dealt with. The end result of properly implementing Lean Six Sigma is an efficient system that supports the goals identified in the beginning of the process, such as providing timely treatments to the patient population by reducing the number of cancellations of appointments within the healthcare facility (ASQ, 2012).

### **Lean Six Sigma in Healthcare**

Lean Six Sigma principles, when used correctly, can greatly reduce waste, minimize variation in a system, and improve quality in a system. This approach to improvement applies greatly to healthcare, as it can reduce defects and medical

errors that can result in improper patient care or even death (DiPiero, 2016). John Hopkins estimates that medical errors contribute to roughly 100,000 deaths per year in the United States and cost the healthcare industry almost \$20 billion each year. The Joint Commission and many other federal agencies have tried addressing medical errors and attempt to prevent them as much as possible through

**Focusing on issues in healthcare that present the greatest time delays would offer the greatest opportunity for improvement in cost, quality, capital, and lead time.**

legislation and regulations (Rodziewicz et al., 2021, “Extent of the Challenge”). Healthcare organizations could take initiative in targeting medical errors on their own by utilizing Lean Six Sigma principles, ultimately avoiding non-compliance of the stringent list of Joint Commission regulations (Rodziewicz et al., 2021).

Lean Six Sigma, in healthcare organizations specifically, can improve quality and efficiency in many areas. With the inherent improvements in efficiency, implementing Lean Six Sigma principles can greatly reduce financial waste and improve revenue flow as well (Vendrame Takao et al., 2017). Lean Six Sigma also improves an organization’s competitive advantages and ability to offer care and services more efficiently than competing providers (Kovach & Borikar, 2018).

In chapter 9 of *Lean Six Sigma Ap-*

*proaches in Manufacturing, Services, and Production*, Lean Six Sigma is described as being able to mitigate activities that cause a customer critical-to-quality issues and create extended service delays (Aboelmaged, 2015). Focusing on issues in healthcare that present the greatest time delays would offer the greatest opportunity for improvement in cost, quality, capital, and lead time. The author goes on to explain how Lean Six Sigma principles aid in the improvement of healthcare systems, stating,

Although the guiding theories of Lean and Six Sigma methodologies are different, they are complementary in nature since both seek to improve the process. Lean philosophy establishes the standards of eliminating waste and reducing cycle time in processes with little impact on process variation, while Six Sigma shows how these standards can be achieved with minimum variation through applying a problem-solving approach using statistical tools and techniques. In addition, lean standards cover the entire organization value chain, while Six Sigma concentrates more attentively on certain projects or processes within an organization. Such integration between Lean and Six Sigma as an improvement methodology brings many benefits to the organization including maximizing shareholder value and improve their satisfaction and cost, quality, and speed of processes. (Aboelmaged, 2015, p. 233)

Over the past two decades, several examples of the implementing of Lean Six Sigma into healthcare-related settings have been observed. A few of the most effective innovations to recently come from the healthcare field have a strong correlation to Lean Six Sigma Principles

## **Management of Finances in Healthcare**

The Healthcare Financial Management Association urges organizations to make quality their top priority (Kaltwasser, 2016). In his discussion with Mark Chassin, president and CEO of the Joint Commission, Kaltwasser (2016) explains how the Joint Commission has been working with healthcare organizations to increase reliability and eliminate errors and failures that impact patient outcomes. In the article, it is clear that Chassin and other Joint Commission officials understand just how significant Lean Six Sigma principles are to process improvement. They continually seek ways to encourage healthcare organizations to implement these principles. To make quality a top priority and excel, performance improvement methodologies like Lean and Six Sigma should be used and applied to long-term goals (Kaltwasser, 2016).

### **Laboratory Execution**

In an article by Chris Stumpf (2012), the successful implementation of an Electronic Laboratory Notebook is analyzed among two top ten pharmaceutical companies. Electronic Laboratory Notebooks are used by researchers to gather information electronically, a modern version of the outdated paper worktop journal. In the first case study, a top ten pharmaceutical company replaced over one thousand paper logbooks with Electronic Laboratory Notebooks, eliminating legibility issues and transcription errors, and improving log retrieval times (para. 3). Stumpf (2012) noted a time savings of 75% in documenting standard preparations, 80% in verifying weight balances, 33% in creating an instrument work list for the Chromatography Data System, and a savings of approximately \$500,000 for the year just from this project (para. 4).

In a second study, another top

ten pharmaceutical company eliminated waste and variability by focusing on updating lab procedures through the use of Electronic Laboratory Notebooks. After updating their information sharing systems, the company realized a cost savings of \$3 million per year by implementing an information hub and exchange vehicle (Stumpf, 2012, para. 6-7). In both cases, Lean Six Sigma workflow analysis was crucial in helping both businesses identify critical waste areas and streamline their processes.

### **Improved Management Supply Chain**

In an article by DiPiero (2016), the improvements in the supply chain management of a healthcare service delivery system enhanced the capability of the overall system. Lean Six Sigma implementation reduced annual costs, eliminated waste production, reduced burden on the healthcare service providers, and improved quality care for patients. Quality of service at the Aquarian Healthcare Solutions improved significantly after they incorporated Lean Six Sigma practices. Effectiveness in their cost-saving solutions towards healthcare enhanced their service delivery. Gagliardi, the founder and president of Aquarian Healthcare Solutions, has a degree in finance as well as a Lean Six Sigma Black Belt (DiPiero, 2016). This “Black Belt” certification represents mastery in Lean and cost control quality improvement through Lean Six Sigma principles. Advancements in technology helped Gagliardi assist her staff with setting up procurement software, efficiently analyzing facility data, and assisting facilities in collaborating with the correct group purchasing organization through stakeholder analysis (DiPiero, 2016).

### **Continued Implementation in Healthcare**

In order to work efficiently with an ever-increasing patient population, healthcare facilities must continually search for appropriate methods to reduce cost and increase quality of care for the patient population (Kaltwasser, 2016). Additionally, the method chosen to attain these improvements must continuously achieve their objectives with limited resources (Zhu et al., 2018). The application of Lean Six Sigma across American healthcare institutions, at all levels, can reduce the processing time and increase productivity of the healthcare facility. The tools used to incorporate Lean Six Sigma within the production cycle of a healthcare facility are from the DMAIC (Vendrame Takao et al., 2017, pp. 2-3). Upon the implementation of Lean Six Sigma, every healthcare facility defines the problem, measures the process, analyzes the supporting data, and implements a series of solutions resulting in increased customer satisfaction. In addition, strategies are implemented to control the process improvements (Yaduvanshi & Sharma, 2017). The outcomes achieved from implementing Lean Six Sigma provide evidence of where corrective action was primarily required.

for more timely and effective care for the patient. Moreover, Lean Six Sigma significantly reduces costs, increases efficiency of health service providers, advances effectiveness of the outcomes, and improves deliverables.

### **Conclusion**

In summary, appropriate incorporation of Lean Six Sigma provides immense benefits to the healthcare system. Lean Six Sigma embeds itself within the culture of healthcare by adding efficiency to the system, achieving high-quality care for the patient population while reducing complications for healthcare providers. Lean Six Sigma promotes technological advancements in order to reduce waste and unwanted steps in a process. Incorporating Lean Six Sigma is possible through a range of various healthcare departments and levels of care. By doing so effectively, the overall functioning of the healthcare system can improve, allowing



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