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Lean Six Sigma Journey in a UK Higher Education Institute: Challenges, Projects, and Key Lessons Learned

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Abstract

Lean Six Sigma is a powerful methodology for achieving process efficiency and effectiveness resulting in enhanced customer satisfaction and improved bottom line results. Although a number of manufacturing and service organizations are utilizing the power of this integrated methodology, Higher Education Institutions have been slow to introduce and develop this process excellence methodology. The purpose of the paper is to critically evaluate Lean Six Sigma as a powerful business improvement methodology for improving the efficiency and effectiveness of Higher Education Institutions. The paper will explore the fundamental challenges and critical success factors encountered with the introduction and development of Lean Six Sigma in administration at a Higher Education Institution based in Scotland. The paper also illustrates examples of the type of projects completed by the staff members at the institute as part of the Lean Six Sigma journey. The final part of the paper reveals some of the key lessons learned from the projects as well as the future directions of the journey. This paper makes an attempt to remove the myth that Lean Six Sigma is confined to manufacturing. It also demonstrates through relevant existing literature and authors' experiences that Lean Six Sigma is equally applicable to public sector organizations and, in particular, Higher Education Institutions. Although Lean has been adopted by a few Higher Education Institutions in the UK and abroad, very few Higher Education Institutions have adopted the integrated Lean Six Sigma approach for waste reduction and variability reduction, which leads to superior performance and enhanced student satisfaction.

Key words: Lean Six Sigma, Process Excellence, Quality, Higher Education

Introduction

The last two decades have witnessed an increased pressure from customers and competitors for greater value from their purchase whether based on superior quality, faster delivery, or lower cost (or a combination of both) in both manufacturing and service sectors [(1)]. Lean is a powerful business process improvement methodology to minimize or even eliminate different forms of waste or non-value added activities. Six Sigma, on the other hand, focuses on the critical to quality (CTQ) characteristics in processes and aims at reducing cost by reducing variability and achieving consistency in performance [(2)]. Any organization applying Six Sigma to reduce variation from its business processes will, after a certain period of time, realize that the benefits begin to fall. Similarly, any organization applying Lean will notice a gradual decline in the returns after a certain period of time. Reducing waste alone cannot improve the process entirely and similarly reducing variation still leaves behind waste in business processes [(3)].

Lean theory proposes that work processes should be designed as a single, continuous flow containing all of the steps which incrementally add value in the eyes of the customer(s) and take the product or service from source to completion [(4)]. In a

manufacturing context, Taiichi Ohno [5] from Toyota sees the essence of Lean as being a system that is able to produce goods, at the rate driven by customer demand, in an uninterrupted continuous flow with minimum spare capacity. In a service context, McBride [6] states that the delivery of services differs from manufacturing in that it consists of not only what the organization does but also, significantly, what the customer does. George [7] argues that service industries can reap huge benefits from the Six Sigma approach. Typically processes in these industries involve significant degrees of variation and the organizations operate close to full capacity. By reducing variation, this will release resources. Lean does not look at variation within a business process, rather it addresses variation between processes. Six Sigma can benefit from Lean thinking, particularly in the areas of elimination of waste and acceleration of process flow. For these reasons, practitioners of Lean and Six Sigma started to develop the thinking towards a merger of the two approaches and Lean Six Sigma (LSS) was born [1].

The integration of Lean and Six Sigma methodologies provides organizations with the methods, tools, and techniques for superior improvements [8]. Lean Six Sigma is a powerful methodology for achieving process efficiency and effectiveness resulting in enhanced customer satisfaction and improved bottom line results. Fitzpatrick and Looney [9] mentioned in a featured article that the combination of Lean and Six Sigma works well because Lean on its own does not typically bring statistical control and capability to operational processes. Equally, Six Sigma cannot dramatically improve the speed of processes. These methods both compliment and reinforce each other to help impact the bottom-line. Bringing the two strategies together to an organization creates a powerful vehicle for value creation.

Although a number of manufacturing and service organizations are utilizing the power of the integrated LSS methodology, it has been clear through the authors' research that the Higher Education Institutions (HEIs) are far behind in the introduction and development of this process excellence methodology [10]. A number of HEIs have embarked on the Lean initiative for improving the efficiency of business processes by systematically eliminating waste (i.e. non-value added activities or steps or procedures). Examples of such HEIs are St. Andrews University (Scotland), Cardiff University (Wales), Coventry University (England), University of Portsmouth (England), Central Connecticut State University (USA), Bowling Green State University (USA), MIT (USA), and Oklahoma State University (USA), to name a few. Several studies have also been performed to measure the impact of methods, such as project based learning, to teach Lean [11,13,12] and Six Sigma [14,15]. Although Lean has been widely accepted by a number of HEIs [16,17], our research has shown that very few universities are integrating Lean with Six Sigma for improving the efficiency and effectiveness of university processes. An example of an HEI utilizing the Lean Six Sigma approach is King Abdullah University of Science and Technology (Saudi Arabia).

HEIs can use both methodologies simultaneously depending upon the nature of the problem at hand. Moreover, the Six Sigma methodology (Define-Measure-Analyse-Improve-Control) can be very effective in solving various business problems in university processes where the solutions are unknown or root causes are never determined in a true sense. In addition, the Design for Six Sigma approach of Design–Measure–Analyze–Design–Verify (DMADV) can be utilized for designing new

processes [11]. The purpose of the paper is to address the challenges, understand the critical success factors, and assess the role of relevant tools and techniques for the successful introduction and deployment of LSS in a higher education setting. A list of sample projects completed by staff members at a university in Scotland further to a two day LSS Yellow Belt training will also be presented.

Case study

Background to the HEI and LSS Journey

The HEI for this research was established in 1796 as the "place of useful learning to combine academic excellence with social and economic relevance". As the place of useful learning, the university is fully committed to the advancement of society through the pursuit of excellence in research, education, and knowledge exchange and through creative engagement with partner organizations at local, national, and international levels. The university set out a clear vision recently, which is to be one of the leading technological universities in the world. Being a leading technological institute, the university embraces all academic subjects from science, business, and engineering to the humanities and social sciences. The university is a home to 26,000 students of which over 16,000 are undergraduate students and over 9,000 are pursuing post graduate courses across the four faculties.

One of the strategic objectives of the university is to become a flexible, adaptive, and responsive organization. In order to achieve this, the university has to challenge the way we operate the business processes cutting across the four faculties and departments. The university needs to establish clear, understandable, efficient, and effective processes and systems so that we can deliver world class experience to our students, industry sector, who are engaged with the university, and the stakeholders who have a vested interest in the growth of our business. As the university accelerates in the delivery of its academic strategy and its increasing collaboration with industry, there is a clear recognition that it must transform its systems and processes to ensure they are fit for a new and dynamic approach to doing business. The university embarked on the LSS journey two years ago, with the aim to build a culture of continuous improvement across the business. LSS is viewed as a methodological approach to business process improvement to increase efficiency, effectiveness, and even agility while achieving cost savings to the bottom-line of the business. The implementation was executed in two phases. The initial phase was focused on Lean Thinking to reduce waste in business processes, streamline some of the administrative and professional service processes, and eliminate some of the obvious bottlenecks which lead to process inefficiencies. The second phase was to introduce the Six Sigma methodology and Six Sigma Thinking to tackle ineffectiveness in business processes, which are primarily result in defects or even failures in the eyes of customers.

Since the launch of LSS journey at the university, over 60 staff members have attended a two day LSS Yellow Belt training. The training is highly interactive and includes many exercises and a simulation that demonstrates how waste and variation occurs in a process and, more importantly, how to use Lean and Six Sigma tools to eliminate waste and variation. LSS Yellow Belts are team members who work with a project leader (a Green Belt or Black Belt) to deliver improvements. The Yellow Belts usually work on projects in their own area of involvement; i.e., they are 'fact holders' in the process under review, they 'own' the process and work in it on a daily basis.

The LSS Yellow Belt certification provides an overall insight to the tools of Lean and Six Sigma, the key metrics of Lean and Six Sigma, and the methodologies of Lean and Six Sigma. The Yellow Belts are expected to demonstrate a greater understanding of processes using the simple tools of Lean or Six Sigma. These Yellow Belts act as members of the Business Process Improvement (BPI) team led by a team of three or four people. As part of successful completion of LSS Yellow Belt, each staff member was expected to complete a continuous improvement project (low hanging fruit) based on the DMAIC methodology and demonstrate the use of tools within the methodology. To date, a total of 25 LSS Yellow Belt projects have been successfully completed across the four faculties. In addition to the Yellow Belts, about 10 staff members have been trained as LSS Green Belts and these Green Belts have attended a five day training covering broader aspects of both Lean and Six Sigma and the power of the DMAIC in solving business process problems. Six Sigma Green Belts are employees who spend some of their time on process improvement teams. They analyze and solve quality and process related problems, and are involved with Six Sigma, Lean, or other quality improvement projects. Lean Six Sigma Green Belt training in the university provided participants with enhanced problem-solving skills, with an emphasis on the DMAIC model. The Green Belt has two primary tasks: first, to help successfully deploy LSS tools and techniques, and second, to lead small scale improvement projects (usually one or two) within their respective areas. The following are some of the characteristics of LSS Green Belt projects used within the university.

- The project improves the performance of an existing process (e.g., defect rate, waste reduction).
- The project attacks cycle time, throughput, etc.
- The project focuses on processes that affect what the customer views as valuable.
- The project can be completed in less than six months.
- The projects tackle problems where the solutions are unknown to the team members and the problems are chronic in nature.

To date, a total of four LSS Green Belt projects have been completed. The total hard cash savings generated from both Yellow and Green Belt projects are estimated to be £250,000 and this will continue to increase over a period of time. Table 1 provides a sample list of projects completed by the staff members at the university. At an institutional level, the following successes were noted in connection with LSS projects:

- Improved transparency of processes,
- Improved morale for staff members across the faculties,
- Improved cross-disciplinary working and, hence, better teamwork and engagement of staff members,
- Established ownership of processes for staff members,
- Reduced cost and time,
- Reduced duplication of work in many departments, and
- Increased awareness of process excellence methodology for improving efficiency and effectiveness.

Project Title	***Objective***	***CTQs***	***Benefits***	***Key tools used***
Rationalizing scanning service processes to achieve time and quality efficiencies	To design and implement improvements to the current scanning service to ensure delivery of required documents	Turnaround time to scan Waste in processes	28 process steps reduced to 18 Involvement of 4 departments reduced to 1 Turnaround time from receipt if request to scan reduced by over 70% Cost savings were estimated to be over £10k	Project charter Process maps SIPOC Seven wastes analysis Cause and effect analysis Histogram
Reducing the number of checks requested in Finance	To identify the cause of check payments within Accounts Payable and investigate ways to reduce while improving the payment process	Prompt payment of invoices	Number of checks reduced from 8,000 per year to 3,500 per year. Reduced costs associated with processing and posting Reduction in staff time Cost savings were estimated to be over £3k	Project charter SIPOC Process maps Histogram Brainstorming Seven wastes analysis Cause and effect analysis
Software management and purchasing processes	To make efficiency savings in the current process	Obtain software within five days from request being raised Provide user with appropriate download/ installation instructions	Purchasing and processing time reduced from months to five days or less Waste of £800 in staff over processing identified and eliminated Identified less expensive supplier of same goods Cost savings estimated to be over £2k per annum	Project charter Process maps SIPOC Brainstorming Seven wastes analysis Cause and effect analysis
Reviewing the Governance Structures of the Information Services Committee (ISC) meetings	To improve the efficiency and effectiveness of the ISC meetings held at the university by the Senior Executive team	Number of meetings held each year Duration of meetings in hours Wastes in the process Number of Executives needed to make decisions	11 boards reduced to 3 19 members reduced to 6 50% reduction in the number of meetings held each year Rework and duplication wastes have been removed Meeting times reduced from over 3 hours to a targeted 1 hour Cost savings estimated to be over £22k per annum	Project charter SIPOC Process maps Seven wastes analysis Cause and effect analysis Brainstorming

Table 1 Sample List of LSS projects carried out by Yellow and Green Belts

Challenges in the Introduction of LSS in the Higher Education Context

This section discusses a number of challenges encountered during the development and introduction of LSS in the university. Some of these challenges are common across a number of organizations despite the nature and size of the organization. The following are challenges that were identified while introducing continuous improvement initiatives in a higher education setting.

- There is a problem with the terminologies taken from manufacturing industry to the higher education sector (we do not make cars at the HEI).
- The strategy of achieving leanness is not clear to many senior executives in the higher education sector.
- A lack of commitment and support from the senior executive team might promote a flavor-of-the-month attitude across the business.

- A lack of systems thinking principles across the sector can result in sub-optimization of the overall performance of some processes.
- A lean initiative should not be viewed as something quick-fix. Womack and Jones [18] cautions that if " Lean is seen as a means of quickly cutting costs to meet budget deficits, organisations fail to achieve the real benefits".
- The culture of the higher education sector can be a big challenge in the introduction of LSS (culture of openness, trust and acceptance).
- A silo mentality across the departments and faculties leads to poor communication across the university.

Critical Success Factors of LSS in a Higher Education Context

Critical success factors, in this context, represent the essential ingredients without which any continuous improvement initiative stands little chance of success. Each one must receive constant and careful attention from management as these are the areas that must 'go right' for the organization to flourish. We have identified the following critical success factors for the implementation of LSS in any HEI.

Strategic and visionary leadership

Dewhurst et al. [19] state that leaders have the role of creating a challenging vision of the future and motivating their employees to its accomplishment. Together, the mission and vision give direction to an organization, and they function as a compass and a road map, leading to better performance. Leadership needs to enable employees at all levels to shift from their current culture to a new culture. No leadership development will succeed unless it is recognized and supported wholeheartedly by senior executives of the business [20]. Leaders must provide the direction by communicating the purpose, value, and progress of the new direction and finally recognizing and reinforcing successful improvements.

Developing organizational readiness

If a HEI is ready to embark on the LSS journey, then a customized roadmap can be proposed to guide the organization through the implementation and deployment process. Continuous Improvement Maturity models provide a roadmap for many organizations to assess their weaknesses, highlight the issues which need urgent attention, and aspire to advance to a higher level in the maturity model [21,22]. A good understanding of the characteristics underpinning different stages of maturity models can help HEIs to evaluate their own positioning in the LSS journey. The lack of sustainable, relevant, and related quantifiable results will indicate whether or not an organization is in a position to embrace the Lean Six Sigma business process improvement strategy.

Organizational culture

Culture shows the behaviors of employees in an organization and strategies that can be managed in support of organizational goals. The power of Lean Six Sigma to create a culture of continuous improvement lies in the combination of changing the way work gets done by changing processes, in addition to educating people in new ways of understanding processes and solving problems. Nothing affects the culture of an organization more than the outlook and behavior of its leaders. When leaders start differentiating "noise" from "signals," ask for what is "critical to quality," and want to see the data that proves or disproves a hypothesis – then the culture of a business starts to change [23].

Project selection and prioritization

Project selection is not only the most essential but also the most challenging aspect experienced during a LSS initiative [24]. Project selection methodologies enable organizations to deal with large volumes of proposed projects, enable comparison to be made between different types of projects, and allow one to forecast which project will give the best return [25]. For a LSS initiative to be successful and achieve long term acceptance within a HEI, the right projects must be selected [26]. Moreover, selection of the right projects will create confidence in management and employees towards the LSS initiative.

Effective communication at all levels vertically and horizontally

One of the problems identified by the authors' is that there is no shared understanding for the purpose of a continuous improvement journey across many HEIs. Poor or lack of communication has been cited as an implementation failure for continuous improvement initiatives across a number of public sector organizations. Only through effective communication will employees be more engaged and work as a team for various problem solving scenarios. Through effective communication, organizations can establish a common language for change and improvement [27].

Key Lessons Learned

The key lessons learned come from the execution and implementation of projects across the university. There were several key lessons learned from the execution of training and mentoring a large number of both Yellow and Green belt projects.

- Taking the right measurements is a significant challenge for HEIs. Appropriate data is not necessarily readily available or indeed easily accessible from the system infrastructure currently in place.
- Terminologies taken from manufacturing and engineering industries are not readily accepted in the higher education sector and many people are uncomfortable using some of the more data-driven and statistical tools and techniques.
- Quantifying process improvement savings is extremely difficult without a recognized framework within higher education to point to. Efficiencies and effectiveness are not as easily measured in less "transactional" areas of the institution.
- Process improvement should consider the whole "system" if it is to be effective across any organization. The devolved nature of some HEIs creates challenges for establishing ownership of key processes and ensuring all stakeholders are active participants in improvement activities.
- The existing culture of the higher education sector is a significant challenge to the introduction of LSS. In order for staff to feel they are part of the organization and openly talk about their improvement suggestions, there needs to be a culture of openness, trust, and acceptance.

Conclusions and Agenda for Future Research

Lean Six Sigma can be a very powerful methodology for tackling process inefficiency problems in the higher education industry. However, this powerful methodology has not yet been widely adopted by many universities and colleges due to the pure misconception that it is only meant for manufacturing companies. Higher Education Institutions can make use of LSS for tackling efficiency and effectiveness of business

processes across the sector. Most of the projects executed by staff members in the university were focused on process and quality related problems in Administration, Finance, Human Resources, and Estates. The next stage would be selecting and prioritizing projects within some of the academic processes such as marking, curriculum development by academics, delivery of high quality teaching, and innovative teaching methods. This paper presents the challenges, success factors, key lessons learned, and sample projects executed at a university as part of the LSS journey. The agenda for future research involves the development of a LSS tool kit for the HEIs, assessment of the impact of leadership for the successful deployment of LSS, and development of a LSS Readiness Index Model to understand the readiness factors which should be in place prior to launching the initiative.

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