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Lean Six Sigma (LSS): A Framework for Improving the Quality of Secondary Education

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ABSTRACT

This paper examined Lean Six Sigma (LSS): a framework for improving the quality of secondary education. The paper also x-rayed the concepts; Lean Six Sigma, quality and secondary education. It went further to discuss the benefits of Lean Six Sigma (LSS) for quality secondary education, and the factors that influence the successful implementation of LSS in secondary education. Based on the discussion of the paper, the writer concluded that Lean Six Sigma has proven its effectiveness in various application areas and can be used to increase efficiency in secondary schools by reducing effort and improving quality. Hence, it was suggested that amongst others that secondary school management should adopt the LSS quality improvement philosophy specifically, the DMAIC model, which has proven to be a powerful tool to achieving quality improvement in organisations like the educational institutions. This will help for a thorough approach to defining, measuring, analyzing, improving, and controlling factors affecting student academic performance (measured by grades) and quality of secondary education.

Keywords: Lean Six Sigma (LSS), Quality, Secondary Education

Introduction

The shifting dynamics of the world economy are forcing governments to reexamine the models they applied in public administration. Changing demographics are shaking up conventional financing structures in developed and developing nation states. As societies become more knowledge-based, they feel an increasing need to improve the quality of education. Education provides a wide range of economic and social benefits for individuals and the society, especially secondary education (Brennan et al., 2013 as cited in Gupta, et al., 2018). However, among the consequences of the changes in education necessitated by paradigm shift in world economy, there are increased competition among schools for continued funding of operating budgets (Quinn, et al. 2009 in Nadeau, 2017), demands to improve accountability (Larouche & Savard, 2012; Svensson, et al. 2015) and major (often draconian) budget cutbacks, often leading to erosion of student-teacher interactions and increased sizes of classroom halls, increased workloads for teachers and much attrition following retirement of staff members (Bandyopadhyah & Lichman, 2007 as cited in Nadeau, 2017).

In view of this competitive pressures, the school management have to accelerate the pace of change to adapt to new ways to improve the quality of secondary education. Schools have to innovate and strive for operational excellence. Six Sigma is the most popular quality and process improvement methodology which strives for elimination of defects in the processes whose origin is traced back to the pioneering and innovation work done at Motorola and its adoption by many companies including GE, Ford, General Motors, Xerox, etc. The primary objective of Six Sigma is to reduce variations, in products and processes, to achieve quality levels of less than 3.4 defects per million opportunities (Vivekananthamoorthy & Sankar, 2014).

Consequently, several organizations have achieved phenomenal success by implementing Lean Six Sigma. Lean and Six Sigma are conceptually sound technically fool proof methodologies and is here to stay and deliver break through results for a long time to come. Motorola had celebrated 20 years of Six Sigma in the year 2007 and as per Sue Reynard in an article in ISixSigma-Magazine. Motorola is a company of inventions and Six Sigma which was invented at Motorola is a defect reduction methodology that aims for near perfection has changed the manufacturing game of Motorola, but it didn't stop there. As the Six Sigma has evolved during the ensuing 20 years, it had been adopted worldwide and has transformed the way business is done (Vivekananthamoorthy & Sankar, 2014). Hence, it is on this premise that this paper sought to look at how Lean Six Sigma principles or methodologies if applied to secondary education can improve its quality. In this regard, the paper reviewed concepts like; Lean Six Sigma, quality and secondary education. The paper also highlighted the benefits of Lean Six Sigma (LSS) for quality secondary education, and the factors that influence the successful implementation of LSS in secondary education.

Literature Review

Lean Six Sigma

Lean is a business transformation methodology and it is derived from the Toyota Production System (TPS). According to Ron and Wright (2018) lean is a quality and productivity improvement methodology introduced in Toyota Production Systems (TPS) which is based on the concept of elimination of waste in processes which had resulted in productivity gain and improvement of speed and flow in the value stream. The principle of Lean can be stated as a relentless pursuit of the perfect process through wastage elimination in the value stream. Lean identifies three different kinds of wastes, using Japanese terminology from the Toyota Production System where lean originated: muda (waste of time and materials), mura (unevenness/variation), and muri (the overburdening of workers or systems).

Every employee in a lean manufacturing environment is expected to think critically about his or her job and make suggestions to eliminate waste and to participate in kaizen, a process of continuous improvement involving brainstorming sessions to fix problems. Lean concept was firstly introduced in 1980's by a research team headed by the Jim Womack, Ph.D., at MIT's International Motor Vehicle Program (Kelly, 2010 in Tannu & Sujata, 2015). Earlier lean methodology was used for the manufacturing industries but now lean can be applied in almost every organization such as the school and in every process. The core idea of Lean is to amplify client worth while minimizing waste.

Basically, lean means making more esteem value clients with fewer assets. A lean association comprehends client value and focuses its key methodologies to constantly expand it. The best objective is to give perfect value to the customer by method for a perfect quality creation process that has zero waste. To endeavor, Lean changes the center of organization like the secondary school from improving separate advances, possessions, and vertical offices to advancing the stream of items and administrations through whole value streams that streams horizontally over assets, technologies and departments to customer (school users).

So, reducing wastages in school along whole value streams, rather than at isolated focuses, makes forms that need less human exertion, less space, less time to make items, less capital and administrations at significantly less expenses and with much defects, weighed against conventional school business frameworks (Tannu & Sujata, 2015). Secondary school organizations can answer changing school users wishes with high mixture, high caliber, modest, and with amazingly quick throughput times. Additionally, data administration gets to be much less demanding and more exact for the school management. Lean specialists have observed that the best achievement can be attained to by systematically looking for out inefficiencies and supplanting them with "leaner", more streamlined procedures.

On the other hand, Six Sigma concept was introduced MOTOROLLA in 1986. Further in 1995 General Electric made this approach central of their business strategy (Wang, et al. 2010). Six Sigma is typically identified with the number of 3.4 defects for every million opportunities. The word Six Sigma is statistically depends on the basis of the provision of things and service at a rate of 3.4 (DPMO). Individuals frequently view Six Sigma as quality control mechanism. Today Six Sigma is conveying business magnificence, higher client fulfillment, and prevalent benefits by drastically enhancing each procedure in a venture, whether budgetary, operational or creation. Six Sigma has turned into successful methodology of a wide range of businesses, from medicinal services to protection to information transfers to programming. The driving force behind any Six Sigma project originates from its essential center – "acquiring breakthrough enhancements a precise way by managing variation and diminishing deformities". The goal is to stretch and stretch rationally not physically (Tannu & Sujata, 2015).

In today's complex and sophisticated higher education services, the methodology is "pulled" to satisfy the individual needs of the college. In any case regardless of how it is sent, there is a generally speaking structure that drives Six Sigma to progressing execution. Six Sigma characteristics include (Tannu & Sujata, 2015):

- A methodology of enhancing quality by get-together information, understanding and controlling variety, also enhancing consistency of a secondary school business forms.

- A formalized Define, Measure, Analyze, Improve, Control (DMAIC) handle that is the outline for Six Sigma changes.

- A solid accentuation on quality. Six Sigma undertakings concentrate on exceptional yield zones where the best advantages can be picked up.

- Internal social change, starting with the help from administrator.

Consequently, Lean Six Sigma (LSS) is a combined process improvement methodology, which was founded on over sixty years of quality improvement efforts, undertaken by the so-called quality gurus Shewart, Deming, Juran, Crosby, Ishikawa, Taguchi and others (Snee 2010 in Gupta, et al. 2018). As its name indicates, LSS is based on both Lean and Six Sigma methodologies, and aims to improve both by combining the individual concepts, methods and tools (George 2002 in Gupta, et al. 2018). Lean Six Sigma is a business strategy and methodology that increases process performance, resulting in enhanced customer satisfaction and improved bottom-line result (Snee 2010 in Gupta, et al. 2018). The combined methodology uses a systematic project approach to improving processes, commonly referred to as DMAIC, from the 5 phases of Define, Measure, Analyse, Improve and Control (Wedgwood, 2016).

Although the Lean Six Sigma methodology has been extensively considered by some literatures for over a decade and has been adopted by several manufacturing and service industries with remarkable results (George, 2003 in Gupta, et al. 2018), areas such the Public Sector has been slower in adapting it (Maleyeff, 2017). This applies in particular to education, especially secondary education setting where its application is of growing importance,

but still remains in its embryonic stages (Antony, et al. 2012, Albliwi, et al. 2014, Gupta, et al. 2018). However, through major changes in the secondary education environment it can be witnessed that LSS is growing in importance within secondary education institutions (Antony 2014). Therefore, Six Sigma hones in on improving the drivers of process performance, while lean looks to reduce any waste in the process to improve flow. (Wedgwood, 2016).

The methodology followed in this paper stressed on the analysis of process helped with the Lean Six Sigma methodology and tools to recommend a process innovation for improvement of quality in secondary education. Lean Six Sigma methodology (i.e. DMAIC) according to Vivekananthamoorthy & Sankar (2014) and Tannu and Sujata (2015) is described as follows:

    i.   **Define:** In the Define phase of the project, the focus is on defining the current state by making the Problem statement which specifies what the team wants to improve upon which illustrates the need for the project and potential benefit. Define process goals in terms of key critical parameters (i.e. critical to quality or critical to production) on the basis of customer requirements or Voice Of Customer (VOC). To attain the goal a survey is conducted within the team members, students and teachers. The first result attained by this methodology was the formal definition from the student's "point of view" for the objective of the project, project targets and project boundaries.

    ii.   **Measure:** The Measure is the second step of the LSS methodology. Here a base line measure is taken using actual data. This measure becomes the origin from which the team can gauge improvement. It is within the Measure phase that a project begin to take shape and much of the hands-on activity is performed. A measure is quantified value or characteristics. In this phase students collect the quantitative and qualitative data to have a clear view on of the current state. Team establish a process performance baseline. The size of the project team is considered to be of 11 students and two mentors. The lead time teaching learning process of the project is considered to be of 3 months. A baseline will be set, so that the gap between current performance and the required performance could be filled.

    iii.   **Analysis:** In this step, the team identify several possible causes (X's) of variation or defects that are affecting the outputs (Y's) of the process. In order to check the correctness, questionnaire is used to obtain the data. The questionnaire obtain from the student feedback form is used to identify the root causes of the process failure. This data helped us to understand the gap between teacher and student.

    iv.   **Improve:** In this step, the team would brainstorm to come up with counter measures and lasting process improvements that address the validated root causes identified that affects output process. The motivation behind this step is to recognize, test and actualize an answer for the issue or cause identify; to some extent.

    v.   **Control**: In this step, process has been measured, data analyzed, and process improved. The improvement that have been made will be sustained. At this point it is important to build an appropriate level of control so that it does not enter into an undesirable state. To build a level of control plan. Redesign report, school business process and preparing report as needed. This phase enhanced the confident in the user as at this level were identified and removed.

Quality

Quality is the extent to which products, services, processes are free from defects. It is performance upon expectation and fit for function. Quality is viewed as an outcome of organisational systems, for example, the use of innovative tools in programme design, delivery, assessment and research (Asif and Searcy, 2013 as cited in Davidson, 2020). Quality is viewed as a mechanism for continuous improvement practices, for example to drive improvement of service design and performance. However, a quality secondary education is that which is based on warm, caring relationship, focuses on the useful and relevant application of knowledge with a goal of competence, and uses a lead-management approach to promote self-evaluation and continual improvement. Secondary schools are continuously challenged to meet increasing school users demands and as a consequence, many have turned to continuous improvement methodologies in an attempt to leverage organisational resources (Svensson et al., 2015). Hence, secondary education sector can adopt a number of frameworks for the implementation of quality.

Secondary Education

Secondary education is widely believed to provide the optimum setting to prepare young people, predominantly adolescents, for healthy and productive adult lives, including participation in social, political, and economic spheres. It is an education level that prepare children for higher level of education specifically known as 'tertiary education'. Knowledge acquired at this level by students helps them to be independent. According to Achuonye (2017) secondary education as the name implies, comes second; that is the second level of the three-tier system of education in Nigeria. Federal Republic Nigeria (2014) defined secondary education as; the education children receive after primary education and before the tertiary stage.

In fact, the missionaries introduced secondary education in Nigeria and it started in the late 1850s. The broad objectives of secondary education are to;

- Prepare students for useful living within the society
- Prepare students for higher education

From the above definitions and objectives, secondary education is the bridge between the primary and tertiary levels. It is the spring board from where all the students of higher education take off and all primary school leavers must pass through to become useful to themselves and society.

In Nigeria, secondary education is of six-year duration and given in two stages, junior and senior levels of three years each. Secondary education completes the provision of basic education that began at the primary level, and aims at laying the foundations for lifelong learning and human development, by offering more subject- or skill-oriented instruction. The launch of universal basic education (UBE) in 1999 as a follow up to the 1977 universal free primary education (UPE) was also an important educational milestone which became a major focus of government in line with its drive to reform the sector. Despite this development, secondary education in Nigeria still suffer a lot of setbacks. However, with frameworks or methodologies like Lean Six Sigma, secondary education can improve their quality outside the traditional ways of operation, considering the benefits derivable from the model.

Benefits of Lean Six Sigma (LSS) for Quality Secondary Education

Lean Six Sigma (LSS) has been used extensively within the manufacturing sector and a range of industries (for example, health care; public sector) to facilitate greater customer focus and achieve savings to the bottom-line (Antony et al., 2017). Pepper and Spedding (2010) as cited in Davidson, et al (2020) contend that the combination of Lean and Six Sigma, if fused together, can potentially represent an exceptionally powerful tool, as it looks to balance the people/culture aspects with the process/tools of Six Sigma. LSS is the most common embodiment of business improvement today (Laureani & Antony, 2012 in Davidson, et al. (2020). The success of LSS as a business improvement methodology has led many organisations across the globe to adopt it in order to create efficient and effective processes, improve customer value and experience while reducing resources (Antony et al., 2017).

In view of this, LSS can be adopted by secondary education institutions in order to offer a structured approach to process improvement (Svensson et al., 2015, Antony, 2014). However, Albliwi et al. (2014) as cited in Davidson et al (2020) note that LSS is still an emerging approach in secondary education institution context and more common in institutions in North America, UK and Europe (Balzer et al., 2015, Nadeau, 2017).

According to Simons (2013) as cited in Davidson, et al (2020), the American Society for Quality has described a number of benefits for the implementation of LSS in secondary education institutions. These benefits include:

- Supporting enrolment and accreditation requirements

- Provision of a template for problem solving

- Foster cross-school organisation collaboration

- Support of the establishment of lead and lag indicators;

- making of processes visible

- Facilitating the voice of the customer (school users)

- Identifying and reducing of hidden costs.

Though, many literatures acknowledged the benefits of application of LSS in secondary institutions administrative setting, to include; student admissions, service requests from students and student graduation (Chow & Downing, 2016, LeMahieu et al., 2017). Hess and Benjamin (2015) highlight a number of opportunities for the application of LSS that considers more broadly the key processes within secondary education institutions such as, curriculum delivery; business and support services; management, marketing and research. Projects that focus on these opportunities have been documented to a lesser degree within the literature. Sunder and Antony (2018) consider this as a result of secondary institutions being in the early stages of implementing LSS and are therefore yet to reap and report the benefits.

Factors that Influence Successful Implementation of Lean Six Sigma in Secondary Education

Antony, et al (2017) advises that there are a number of elements that must be in place to increase the probable success of any continuous improvement implementation of Lean Six Sigma (LSS) for quality secondary education. These are referred to as critical success factors and include: intrinsically motivated academic and professional employees who demonstrate an inspired and resourceful attitude; leaders who can facilitate change through a clear vision and open communication; the use of data to make decisions rather than gut-feel. These factors are discussed in briefly below:

- **Planning and co-ordination of LSS implementation in school:** The implementation of LSS brings many challenges to schools. Antony (2015) emphasise that there is a general lack of awareness of the benefits of LSS outside of the manufacturing industry. Similarly, Thirkell and Ashman (2014) posit that the adoption and implementation of lean thinking can only succeed when an organisation understands and embraces the concepts. Therefore the planning and development of a customised LSS road map is a critical success factor for quality secondary education (O'Reilly et al. 2017).

- **Customer focus:** Chow and Downing (2016) advise that the secondary education institution necessitates the adaption of LSS methods to meet the unique structure and operating environment. Literature has highlighted that secondary schools administrators have had difficulty in identifying their customer (school users) and their needs (Jenicke et al., 2008 as cited in Davidson, et al. 2020) and this has had an impact on the ways in which problems are responded to. It is understood within the LSS methodology that all problems are in response to customer needs (LeMahieu et al., 2017) and therefore the way in which customer needs are understood is vital.

- **Organisational leadership and culture:** Secondary school leaders may choose to implement LSS simply because they have learned of the benefits from others or because they know about its success in other service organisations (Pamfilie et al., 2016). They contend implementing LSS is not simple and requires school leaders to convey confidence and commitment to the program to assuage doubts from staff and foster a culture of improvement— resultant in increasing staff loyalty and improving workplace efficiency (Davidson, et al 2020). To introduce LSS in secondary school requires significant changes in how it conducts activities. Fundamentally, principals, teachers attitudes and behaviours are critical to the successful implementation of any improvement program (Antony, 2014).

- **Communication:** Antony et al. (2017) highlight the importance of communication across the various levels in secondary education institutions. Without effective communication staff may perceive their participation to be pointless. Communicating the need for LSS and the critical role staff play in achieving the strategic goal from the outset has proven to be a successful approach as described by O'Reilly et al. (2017).

Conclusion

Lean Six Sigma has proven its effectiveness in various application areas. Within so many manufacturing sector and a range of industries, it has improve their customer focus and quality with much savings and avoidance of wastages. Hence, this paper concluded that Lean Six Sigma if applied in education especially at the secondary school level can be used to increase efficiency of the school by reducing effort and improving quality considering its various benefits and factors that influence successful implementation of LSS as highlighted in this paper.

Suggestions

The following recommendations are put forward based on the conclusion of this study.

1. Secondary school management should adopt the LSS quality improvement philosophy specifically, the DMAIC model, which have proven to be a powerful tool to achieving quality improvement in organisations like the educational institutions. This will help for a thorough approach to defining, measuring, analyzing, improving, and controlling factors affecting student academic performance (measured by grades) and quality of secondary education.

2. The principals as secondary school heads should always consider LSS methodology to address the issue of wastage in school. This is because it has been proven that LSS methodology have a large and significant effect not only on the students, but also on parents, school administration, teachers, and school staff.

3. The government should ensure that application of LSS principles are adopted in schools since it has a strong tendency to change school administrator's commitment to continuously motivate teachers and school staff to the process of change.

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