The Role of Six Sigma in Improving the Quality of Higher Education Institutions

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Abstract—The quality of education is more important to the customers of the educational institutions such as students, parents and the organizations where they are getting employment. Educational Institutions require an innovative supporting tool which helps in improving the quality of processes pertaining to the important functions particularly teaching, research and service. Institutions of higher education can also improve their chances of attracting students by improving the levels of service. To find success, they must demonstrate that they can offer what others cannot. Six sigma five phase methodology i.e., DMAIC (Define - Measure - Analyse - Improve - Control) is adopted to establish a novel approach with a view to improve quality in a higher education institution. A synergistic approach created by analysing and simultaneously using the benefits of Six Sigma plays an important role in the development and improving the quality of a higher education institution. The purpose of this paper is investigation the role of six sigma in improving the quality of higher education institutions for the development and growth of universities.

Keywords—DMAIC; Higher Education Institutions; Six Sigma; Quality.

Abbreviations—All India Council for Technical Education (AICTE); Continuous Quality Improvement (CQI); Define - Measure - Analyse - Improve - Control (DMAIC); Higher Education Institutions (HEI).

I. INTRODUCTION

At a time when most colleges and universities around the world rely on specialization, learning, development of internationalization and strengthening ties with the company, opting for excellence and helping students to materialize their project are also a great challenge to these facilities [Chambers & Fernandez, 8]. Permanent and rapid evolution of techniques and technologies, tools, regulations, etc. impose to meet the challenge of quality in higher education. The business world is changing; the programs offered in universities should also evolve [Abdellatif Megnounif et al., 1]. The quality university world. The need for improving the quality of higher education does not only affect students but also teachers, managers, employers, the institution and finally all components of the system “higher education”. The study of the quality of all these parameters will lead us inevitably to much longer and complex work. Improvements in the education has been proven in many studies to have positive effects to ensuring equality of opportunity in education, reducing learning time and education costs, increasing the number of individual experts or Professionals, providing social awareness [Eroglu, 11]. Quality assurance system in higher education institutions are the activities offering quality services to satisfy the minimum needs of all parties benefiting from higher education facilities and giving them confidence such as inspection, evaluation and review. The quality in higher education consists of accreditation system evaluating higher education’s input, valuation system evaluating output and total quality system designing, planning and implementation of the processes. The Six Sigma methodology is one of the most popular business practices used today. A 6 Sigma business process “produces only 3.4 defects per million opportunities” [Goffnet, 13] with other words the concept is used for processes that, virtually, perfectly meet the customers’ requirements and needs. The Six Sigma process translates knowledge and awareness into an open opportunity for expanding business. The six sigma method is a project-driven management approach to improve the organization’s products, services, and processes by continually reducing defects in the organization. Recently, a number of articles has focused on the importance of six sigma for services and the challenges of applying this quality
Six Sigma is a structured approach and a discipline. DMAIC (Define, Measure, Analyse, Improve and Control) is the most familiar model of Six Sigma to the Industries in general, which is applicable to both process and product Industries. This model leverages effective utilisation of existing resources, without any additional investments on resources or infrastructure to achieve entitlement [Ramanan & Ramanakumar, 27].

The motivation of this research are to Including the use of Six Sigma quality improvement in HEI and the role of Six Sigma is to improve the quality of these institutions. The objectives of this research are to the introduction of Six Sigma as a way to improve the quality of HEI. The contributions of this manuscript are this paper to deliver a broader framework of DMAIC approach to impact quality of HEI at the micro level of Institution themselves by leveraging the success of Industries in applying six sigma for complex problems.

II. LITERATURE REVIEW SIX-SIGMA

Six-Sigma is a concept that was originated by Motorola Inc. in the USA in about 1985. At the time, they were facing the threat of Japanese competition in the electronics industry and needed to make drastic improvements in their quality levels (Adams, 1998). Six Sigma was a way for Motorola to express its quality goal of 3.4 DPMO where a defect opportunity is a process failure that is critical to the customer). Motorola originally developed Six Sigma in 1987 and targeted an aggressive goal of 3.4 ppm defects. Six sigma is a business strategy that seeks to identify and eliminate causes of errors or defects or failures in business processes by focusing on outputs that are critical to customers [Snee, 26]. While the original focus of six sigma was on manufacturing, today it has been widely accepted in both service and transactional processes. The fundamental objective of the six sigma methodology is the implementation of a measurement-based strategy that focuses on process improvement and variation reduction. Six sigma strategy places a clear focus on achieving measurable and quantifiable financial returns to the bottom-line of an organization.

Examine the current state of six sigma application in services based on quantitative and qualitative analysis of the literature and identify critical success factors and key performance indicators as management guidelines for effective applications of six sigma in the service industry [Chakrabarty & Tan, 7]. Prescribes ways how to effectively implement six sigma in service organizations. Some studies have investigated the success factors for implementing six sigma in world-class organizations [Antony, 2; Antony et al., 3; Biilos, 5; Eckes, 9]. Propose a framework for applying six sigma in institutions of higher education. Six Sigma is a continuous modern quality improvement philosophy that has been provided some well documented improvements for the products and profits in many business organizations [Brewer, 6; Jenicke et al., 16]. The primary goal of six sigma is to minimize defect levels in the outcome of a work process; a defect being anything that causes customer dissatisfaction. Maximizing customer satisfaction leads to improved bottom-line performance and global competitive position. This is a data-driven method for dealing with defects, waste and quality problems in manufacturing, service delivery and other business activities. Six Sigma is a business improvement methodology that focuses on an institution on: Understanding and managing student’s requirements, Aligning key business processes to achieve those requirements. Utilizing rigorous data analysis to minimize variation in those processes and Driving rapid and sustainable improvement to educational processes.

Each Six Sigma project has five phases, in which each phase requiring a review. The review may result in one of the three outcomes: continue to next phase, stop project, or continue study in current phase [Chambers & Fernandez, 8]. Within each phase, data is collected and analysed statistically to aid decision-making. Six Sigma may be a data driven approach that uses reviews at the end of each phase. The five phases are: Define Scope, Measure, Analyse, Improve, and Control (DMAIC). This DMAIC methodology is designed specifically for improvement of existing processes. The deployment of Six Sigma consists of Champions, Master Black Belts (MBB), Black Belts (BB), Green Belts (GB) and Team members (TM) [Brewer et al., 6]. In addition to the requirements for top management support and structured implementation, Six Sigma includes the rigorous application of statistical tools to increase profits, reduce costs and improve quality and speed.

III. CONTINUOUS QUALITY IMPROVEMENT (CQI)

Improvement process phase based on input from various stakeholders enables identification of defects in the curriculum development that hinders the process of nurturing graduates with desirable traits. As such, it ensures that tailored courses have kept in view and have synergized with developments and trends in technology and the industry’s needs. The quality management a very important matter for many universities which have adopted new methods of searching on the work control, organization and planning market, all considering the improvement of tests. In the Educational Quality Management most common use, education quality refers to the extent that an education system is able to achieve the generally accepted goals of education, central to which is knowledge and skill [Fuller & Clarke, 12]. Six sigma is not just a way of measuring the level of quality, it is a way of determining weaknesses; where the organization could do better; and how to serve the customer better [Antony, 2; Antony et al., 3; Edgeman et al., 10]. A higher education institution should develop a system specially designed for collecting and assessing the necessary data. To make appropriate and sound decisions the data and
the information should be clear and accessible and should be first analyzed [Olaru et al., 20]. Improved by applying the Six Sigma methodology: academic achievement, the process of college admission, teaching and academic programs, study program and process, institutional effectiveness, student learning performance, evaluation of the instructional delivery, the accreditation process.

IV. QUALITY CULTURE OF HIGHER EDUCATION INSTITUTIONS

Quality culture includes values, beliefs, attitude, commitment, expectation, agreement, capacity, negotiation, participation, unity and trust of the individuals, groups and stakeholders involved with the quality. Quality culture is one of the most important factors that are to be considered not only for improving the processes in the education system but also to be leveraged on to increase enrolment, monitoring of poor progression and passing rate, to reduce attrition rate as well as to ensure employability of its graduates. This is because higher education has become more commercialized and is now treated as a market commodity. It is of great importance that developed curriculum is reviewed periodically for improvement in order to sustain production of holistically competent graduates for the workforce. Furthermore, the quality culture in higher education institutions is the culture stress in terms of values the workforce holds which is a face-off between the values related to the general quality administration principles emphasizing effective management and the higher education institutions’ traditional values emphasizing profession [Berings, 4]. Quality culture of higher education institutions is closely related to the organizational culture and, as such, always exists in the form of values, beliefs, customs, traditions, behaviors etc. The goal of HEIs (Higher Education Institutions) is a genuine quality culture supported by well-functioning quality assurance processes. In every organization and also in a higher education institution, building a quality culture must meet certain features required for every employee in the organization, namely: accepting a philosophy of quality culture at all levels of the organization; providing an efficient communication between departments, between departments and management, between employees and management; particular emphasis on the importance of human resources; rewarding and recognizing outstanding employees; achieving an effective communication through an internal network; implementing a strong system of values and high standards of performance in the domain.

V. SIX SIGMA IN HIGHER EDUCATION INSTITUTIONS

Today higher education has become commercial enterprise and is treated as marketable commodity [Brewer et al., 6]. Many institutions and universities throughout the world are preparing for marketing their educational products and services. Day by day the competition from various institutions and universities is mounting up. Quality of education is going to be of foremost importance in all further higher education. Many institutions take a departmental, rather than a holistic enterprise, approach and create silos of information, resulting in information that can't be leveraged by everyone. The institutions also focus on the administrative side, but not the academic side of capturing documents, missing on opportunities to collaborate, share knowledge and improve course work. Emphasizes that “First Six Sigma focuses on reducing process variation. Then it addresses improving the capability of that process” [Little, 19]. According to Little (2003), there are three key elements to achieving (Six Sigma) quality: customers, processes and define quality and expect – among other things – performance, reliability, time delivery, service, and clear and correct transaction processes” [Jenicke et al., 16] emphasize that customer definition is one of the challenges in the implementation of Six Sigma in an academic environment. They list other challenges as the difficulty in measuring quality and analyzing data, the limitations of academic reward systems, and the influence of uncontrollable factors on student success, faculty success, even organizational success [Jenicke et al., 16]. Educational institutions exist as long as they are useful. They and their social environment are continually developing: they all have a "life" cycle consisting of four main stages: foundation-formation, growth-expansion, maturity and the last stage, which can lead either to decline or revival. The decline in the life cycle of educational institutions can be avoided provided that the process of periodic revitalization is carried out permanently.

VI. APPLICATION OF SIX SIGMA– DMAIC METHODOLOGY

Recently six sigma as an improvement approach has gained wide popularity in many service sectors such as banks, healthcare centers, utilities services and Airline industry primarily to gain customer confidence and to boast business growth. In fact education segment is of no exception as it is fast inclining as a profit generating business enterprise with minimal impact towards nation building. Six-sigma is an improvement strategy geared towards reducing defects on existing products and strategies efforts in improving business growth and sustainability. This methodology has two techniques which are known as DMAIC (Define, Measure, Analyse, Improve and Control) and DFSS (Design for Six sigma). The main difference between these techniques is that DMAIC is a process improvement strategy applied on developed and existing project or system while DFSS is geared towards designing new product or process. The process is illustrated in figure (1).
Define: The institution’s purpose and scope are well defined during this phase. To identify problems, form a team, identify customers and identify required outputs, to prioritize student’s requirements, document the current process and complete requirement definition. Tools used; Value Stream Mapping, MS-Word/EXCEL, Flowchart, Gantt chart/ Timeline Suggestions / Complaints, and Surveys / Interviews.

Measure: It evaluates the "as is" process, and creates a current-state assessment of the current service delivery. This phase will help the organization rank the potential causes, to identify what is to be measure, types of variations, accuracy of measurements, conduct the measurement, calculate current sigma level, determine process capability. Tools used: Measurement Systems Analysis, Process Metrics, Data Gathering Plan, Surveys/Interviews, Check sheets, Control chart, Flowchart, and Gantt Chart / Timeline.

Analysis: It produces the baseline performance of the service delivery process. In this phase the collected data in the measure phase have been examined to generate a ranking list of the sources of variation, to identify the root cause of problems, to determine brainstorm ideas for processing students’ improvements, determine which improvements have the greatest impacts on students requirements, develop proposed process map and assess risks associated with revised process. Tools used; Run Charts, Scatter Plots, Fishbone Diagrams, Control Charts, Histogram, Correlation Analysis, Confidence intervals, Regression, Response surface method and Flowcharts.

Improvement: This phase is to identify options for solutions which can be useful for the identified problems during the analysis phase. Recommendation and implementation, to gain approval for the proposed changes, the impact of assessment, finalize the implementation plan, implement the approved changes and the solutions are the most important objectives of this phase. Tools used; Basic Lean Tools, Design of Experiments Overview, Cost Benefit Analysis, Hypothesis testing, Confidence intervals, Trial/Error Simulation, Flowchart, Implementation and validation Plan.

Control: Obtained knowledge in the improvement project can be published in other areas to help accelerate improvements of service delivery. To establish the key metrics is to develop the control strategy, celebrate and communicate success, implement the control plan, measure and communicate improvements. Tools used; Error & Mistake Proofing, Control Plans Basics, SPC Basics, Capability studies, Documentation, Final Report. One of the important aspects of six sigma is the involvement, training and reward of employees at all levels of the organization [Durga Prasad et al., 17].

Students can use Six Sigma principles for better understanding of the data which are useful (Measure) when gathering requirements and how to avoid collecting data that distracts rather than help a user. When an institution wants to introduce Six Sigma for its management strategy, the author would like to recommend the following procedures.

- The institution should ensure that the students are to be competent with a full understanding of theory and have the diligence to guarantee that deadlines are met.
- To run laboratories with latest equipment’s and licensed software’s which are shown to be sufficient when compared with other organizations.
- The philosophy of the education curriculum is to produce good graduates who could teach several courses to develop computer assisted teaching software and to develop a computer programs with a positive attitude and could systematically utilize computers in the workplace. For that purpose, the institution should also do the following:
- Organize a team and set up the long-term management vision for an institution
- Start Six Sigma education for Champions first.
- Select the area for which Six Sigma is introduced first.
- Strengthen the infrastructure for Six Sigma such as Statistical Process Control (SPC), Knowledge Management (KM), and Data Base Management System (DBMS) and so on.
- Designate the Six Sigma day each month, and check the progress of Six Sigma from the top Management. If necessary, presentation/reward of Six Sigma results can be implemented. The core of Six Sigma is defined as $Y = f(x)$, where $Y$ is the product or service that has to be improved and $x$ is a set of factors that influence $Y$. 'f' is the function that defines the relationship between 'Y' and 'x'. Six Sigma is all about finding the critical 'x' which affect the 'Y' or output of the process (Product or service). Six sigma offers institutions of higher education a powerful mechanism which is to examine the efficacy of their offerings and to improve them. At present most of the manufacturing sectors are gaining more benefits by adaptation of quality concepts like TQM, Six Sigma, Kaizen, 5S and others.
- Once Six Sigma is successfully deployed on all existing work processes on an institution campus, the next task is to determine the outcomes of these existing work processes align with the justifiable needs and requirements of the society.

VII. CONTRIBUTIONS OF SIX SIGMA TO IMPROVE QUALITY

An excellent overview of six sigma’s assumptions, motivations, steps and tools can be found in de Koning and de Mast (2006). Two basic references which provide a comprehensive coverage of view of this approach are [Pande et al., 21; Pavel Adina-Petrula, 23]. In this section we identify and discuss four fundamental contributions of six sigma to the quality movement.

- Six sigma as a philosophy
  A critical contribution of the six sigma philosophy is the realization that the variation of an operation impacts the rest of the process very significantly.
- Six sigma as a quality standard
  Six sigma can also be interpreted as a quality standard, in fact a rather stringent one.
- Six sigma as a continuous improvement methodology
  Six sigma focuses on more advanced statistical methods (such as experimental design, fault analysis, simulation); and six sigma projects are much more accountable in terms of return on investment than TQM projects ever were [Antony, 2; Green, 14; Pyzdek, 24; Senapati, 25].
- Six sigma as an organizational change agent and motivational tool

Six sigma is a philosophy that benefits everyone from the customers to the shareholders and even the suppliers and employees [Chakrabarty & Tan, 7].

VIII. CONCLUSION

Six Sigma is a process that brings additional benefits and helps institutions to adopt best practices for service delivery through a quality process which ensure its success. This paper has discussed two approaches which are highly complementary and can be used in combination effectively for the continuous quality improvement of an educational process. The DMAIC, a standard six sigma process is proposed as it has gained vast positive reviews of its capabilities. Furthermore, an attempt has been made to establish a relationship between this popular industrial methodology and the scope of study in an academic environment involving undergraduate engineering program. This is to ensure that academic institutions are committed towards producing innovative talent graduates and are not deviated towards commercial motives. Cultural changes require time and commitment before they are strongly implanted into the organization. In its most common use, education quality refers to the extent that an education system is able to achieve the generally accepted goals of education, central to which is knowledge and skill development. Our Conceptual Framework propose a new insights to the managers in organizations that typically interact with education and quality.

Just like ISO 9000, Six Sigma focuses on quality improvement by reducing the defects and flaws in the processes of delivering educational services. To be successful in universities and colleges, Six Sigma and other improvement initiatives should be aligned with element (e.g., accreditation efforts and/or institutional effectiveness departments which are responsible for data analysis and report submissions). And national quality initiatives, including finally, students should be involved in Six Sigma and other excellence initiatives. After all, students are the ultimate stakeholders. They are customers, in co-managers of the teaching/learning process, and final products as they graduate and seek employment. Higher education institutions should more often consider and refer to Six Sigma as a success strategy in maintaining academic quality at high standards, improving it continuously and reaching a higher level of performance.

REFERENCES


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