Six Sigma in Education System: A Review

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Abstract—Quality in education became an important fact due to increasing competitive environment. The quality in education is more important for the educational institution and the organization. In India there is a need of clarity in education as well as common understanding of education. The six sigma five phase methodology DMAIC (Define-Measure-Analyze-Improve-Control) is used to improve the quality in an industry as well as in education system. In this methodology process map with SIPOC (supplier-input-process-output-control),FMEA(failure mode and effect analysis),Pareto diagram, cause and effect analysis and histogram etc. are used. These are the tools which we can use for better understanding of higher education system and to meet required quality in an education system. This review paper is focusing on the study of educational system with the use of operational tools and techniques which are used to get excellence in an educational system.

Keywords: Six sigma, educational system, DMAIC, FMEA.

I. INTRODUCTION

The literatures on six sigma reviews that Carl Frederick Gauss in 1800s defines the concept of a normal curve. After this Walter Shewhart proved that there required a correction in the three sigma process because it does not met the required specification. In 1980s a Motorola engineer Bill Smith proved that six sigma is a process to meet the required specification at optimum cost. Six sigma is a quality improvement methodology required for improvement in product and maximizes the profit of various organization [1]. Six sigma is a quality improvement methodology which focuses an institution to understand and manage the students requirement, make a suitable business process to meet that requirements, using various data analysis to control the variation in those process. Statistical process control charts and run charts are those tools which are helpful in large amount of outputs such as in manufacturing process or when there is large number of Students in a university[2]. Basically six sigma methodology consist of five phases and each phase passes through a review process. The review comes in with three results proceed to next phase, stop project and continue in current phase [6]. It is a typical task to define quality engineering education but we can define it as how can it satisfy our present and future requirements of education system and industries. According to U.S. National Science Foundation (NSF) quality in engineering education is development of the knowledge and intellectual skills in the graduates by which they contribute to society by keeping their career as leader, innovators and decision makers in the global economy of this century [4]. Education has various effects on all the fields of development in asbulate country. India is a largest network systems of higher education by recognizing the importance of higher education on science and technology. This method uses the moderate complexity statistical tools which consumes a short cycle time and focuses on elimination of waste[5]. According to six sigma approach for a process to be stable the distance between the nearest tolerance limit and process mean should be at least six times the standard deviation of the process output[7].

II. IMPORTANCE OF SIX SIGMA

Six sigma is a statistical tool used to measure the variability in processes. Generally companies adopted three or four sigma performance levels which do not give the satisfactory results. Six sigma provides the guidelines to do the things right at the first chance and to work well by using data information. Six sigma provides us team efforts to solve many CTQ (critical-to-quality) problems. Six sigma statistical representations defines quantitatively, how a process is performing.Amazon.com, American Express, Bank of America, and Microsoft are among the service organizations that are being recognized as having excellent results with Six Sigma methodology [8]. For manufacturing industries, the process sigma level is usually calculated based on defects per million opportunities (DPMO) and within a range of 3 to 4[9]. The process sigma level for service organizations is usually calculated based on defects per million units (DPMU) and within a range of 1.5 to 3 [10]. Six Sigma methodology is helpful in offering a structured problem-solving approach for both documenting and improving student-retention processes and disseminating process-improvement plans and results. Yet, implementations of Six Sigma methodology in academia are not as commonly seen as in the manufacturing and other service sectors [11].

III. ROLL OF SIX SIGMA IN EDUCATION SYSTEM

In the contest of globalization, the education systems have gone through many changes. Today higher education has become a commercial enterprise and is treated as marketing resource. Most of the institutions and universities in the world are preparing for marketing their services and educational products. The competition between the universities and institutions is growing up. In developing e-learning environments most of the higher education institutions faces the significant challenges. They think as to how the e-learning tools can be used to enhance university student learning [12]. Six sigma is a best methodology for improving the business performance. Six sigma quality improvement techniques are successfully applied in the service sector and very recently in education enterprise [13]. Educational institute have to make regular educational environment evaluation, which makes students to indirect participation in decision-making, which is the most essential quality assurance activities associated with higher school improvement. It also used to emphasize the significance of measure the student satisfaction in education [14]. The present day graduates with already known facts of science are not able to solve industrial problems [15]. Recently there has been an increasing in the number of institutions in India. There is no satisfaction in overall performance and quality
of education overall performance in most of the institutions due to student failures in university examinations, less placement opportunities and other factors. To improve the quality of education and placement activities, the AICTE has guided the institution to improve in the field of higher education.

Due to the success of this method, most of the academic institutions used six sigma methodologies to improve the quality of education and services. This methodology has great potential for improving process efficiency and quality in education.

IV. METHODOLOGY
Statistically Six Sigma defines its quality by limiting the number of defects to 3.4 in millions of opportunity (DPMO). The term Six Sigma refers to the six standard deviations away from the mean in a normal distribution or bell shaped curve. It measures the factors in a process and works on to improve the output and continuously improving the process as well as system. In a six sigma process defects are the total area to the right and left of +6σ and -6σ respectively as shown in Fig. 1.

Among different approaches used for achieving the six sigma level of quality, the DMAIC methodology is used on most and the focus is on the continuous improvement in the process. DMAIC is an abbreviation for Define, Measure, Analyze, Improve and Control. The following section of the paper attempts to demonstrate how DMAIC methodology can be used to continuously improve the quality in the educational system.

A. Define
In the define phase, problem or statement of the project is defined. The goals of the improvement activity are clearly defined. The critical to quality (CTQ) are defined, these are the parameters which greatly influence the goals of the enterprise with respect to quality. The process map (SIPOC chart) starts with supplying raw materials and ends with the benefits received by the customer. To identify the problems, first of all form a team, identify the customers, and identify the required outputs, to prioritize student’s requirements, document the current process and complete requirement definition.

B. Measure
In this phase the data related to critical to quality are collected. The statistics such as standard deviation (σ), sample mean (μ) and process capability indices Cpk and Cp for each CTQ are calculated. In the measure phase we have to develop, execute and verify the data collection plan. Tools that are typically used in the Measure phase are Process Flow Diagrams, Failure Mode and Effects Analysis (FMEA), and measurement system analysis. In this phase, the students are able to understand what they have to measure or validate in order to know the Voice of the Customer (VOC) as well as identify Critical to Satisfaction (CTS) characteristics. The students should be able to understand the facts and data to build knowledge which would be used to make decisions. In this phase process capability analysis is done. Process capability means how much a process is able to meet the required specification. A process capability index compares the behaviour of a process or product with required specification. The data measure in this phase are further analysed in analyse phase.

C. Analyse
The data collected in measure phase is analyzed in this phase. After measurement of the collected data, it is important to identify the causes for poor quality in an education system.

D. Improve
The data collected and verified in analyse phase is re-analyzed and re-verified in this phase and based on the causes identified for poor quality, the steps to achieve the required specification are identified and the process is improved.

E. Control
The actions taken in improve phase are verified in control phase. The process is controlled to create a system which helps in sustaining the improvements in the process.
In this phase, with the help of certain tools such as Pareto diagram and Fishbone diagram (Cause and Effect diagram), critical analysis is carried out. Basically fishbone diagrams are used in the system to identify the root causes that creates problems in the system. These diagrams help us to determine which of the causes have the greatest effect on the system. We take an example of cause and effect diagram of a case study of an institute which shows that the failure mode is low passing rate of the students and the cause is education provided. The effect of this failure mode is dissatisfaction of the customer about the institute.

A Pareto diagram is a bar chart in which the various factors that involves in effecting the system are arranged in order according to the magnitude of their effect. Six sigma is a statistical tool used to measure the variability in processes. Generally companies adopted three or four sigma performance levels which do not give the satisfactory results. Six sigma provides the guidelines to do the things right at the first chance and to work well by using data information. Six sigma provides us team efforts to solve many CTQ (critical-to quality) problems. Six sigma statistical representations define quantitatively, how a process is performing. Amazon.com, American Express, Bank of America, and Microsoft are among the service organizations that are being recognized as having excellent results with Six Sigma methodology [8]. For manufacturing industries, the process sigma level is usually calculated based on defects per million opportunities (DPMO) and within a range of 3 to 4 [9]. The process sigma level for service organizations is usually calculated based on defects per million units (DPMU) and within a range of 1.5 to 3 [10]. Six Sigma methodologies is helpful in offering a structured problem-solving approach for both documenting and improving student-retention processes and disseminating process-improvement plans and results. Yet, implementations of Six Sigma methodology in academia are not as commonly seen as in the manufacturing and other service sectors [11].

![Pareto Diagram](image)

**Fig. 5: Pareto Diagram**

A Pareto chart is a series of bars whose heights reflect the frequency or impact of problems.

**D. Improve**

This phase is to identify options for solutions which can be useful for the identified problems during the analysis phase. In this phase the various types of failures are identified by Failure Mode and Effect Analysis (FMEA). The main purpose behind conducting FMEA is to anticipate all possible types of failures that could occur in the process. The Improve phase is focuses on formulating the improvement ideas and implementing them on to the process. The various tools used in this phase are design of experiments and multiple regression analysis.

In the improvement phase, the causes of failure or poor quality must be identified with asolution to reduce the defects in the process.

**E. Control**

In the DMAIC process the final phase includes controlling and monitoring the process. A strategic approach for long-term success of the improvements is ensured in the control phase. To monitor the system performance control charts are used. Six sigma methodology the control charts are an effective way of statistically keeping a track of performance and using the data for continuous improvement. The entire possible specific identified problem from the analysis phase was tackled in this phase. This phase aims to institutionalize the results that were coming from improvement phase are implemented through documentation and standardization of the new procedures.

**V. CONCLUSION**

Six Sigma is based mainly on understanding the customer expectation and needs and works for improving, managing and establishing new business or service process. Six Sigma is a process that brings additional benefits and helps the institutions to adopt best approach for service delivery through a quality process which ensure its success. The main aim of an education system is student success by providing higher quality education where failure of any student in the may be considered as a defect in the process. After identification of the problem, a solution should be developed using six sigma methodologies.

**REFERENCES**


