SIX SIGMA LOOK AT IN EDUCATION: A MANAGING PERCEPTION

Dr. Prabhakar Kaushik*

ABSTRACT

Service sector accounts for a substantial share in Indian economy and among the service industries, education sector is emerging as a major commercial activity in the nation. Globalization, growing competition among institutions, emergence of new technologies, changing socio-economic profiles of nations and knowledge driven economies have created a scenario where quality in education is beginning to occupy the centre stage. Now the quality is no more a desirable strategy – it has become a survival strategy. In such a scenario, 'Technical Education Institutions' require an innovative supporting tool which helps in improving the quality of education system. In industry, a company may look at defects in its final manufactured products but in engineering education, these defects are related to capabilities of the students. This paper aims to applying, Six Sigma DMAIC approach, to increase performance of students of a technical institution. The curriculum, qualifications of the faculty, better infrastructure facilities and understanding level of the students play paramount importance in maintaining the high passing rate of engineering students. This paper is an attempt to justify the highly useful role of management techniques like Six Sigma for service sector which are normally presumed to be in the domain of manufacturing and process industries.

Keywords: *Six Sigma, DMAIC, DPMO, CTQ*

*Associate Professor, Mech. Engg. Dept., UIET, MDU, Rohtak.

1. INTRODUCTION

Service sector has experienced significant growth over the past several decades and it accounts for a substantial share in Indian economy. Even in under developed countries, the service sector still accounts for a substantial part of their economies. The service industries not only have grown in size, but along the way, these have absorbed all the jobs rejected by traditional industries such as agriculture, mining and manufacturing. For instance, by the mid-1990s, the service industries employed nearly 80% of the workforce in the USA **(Su *et al*.** 2006). According to Pandey (2007), most service organizations operate at sigma quality levels of 1.5 - 3.0 (i.e. a defect rate between 455000 and 66800). This is not surprising, considering that for decades service sectors have been neglected in the context of quality improvement efforts.

Recently Six Sigma as an improvement approach has been seriously attracting the attention of service industry. The popularity of Six Sigma in service organizations is growing exponentially, especially in banks, hospitals, financial services, airline industry and utility services. Quality of education is going to be an issue of foremost importance in future in India and is an urgent need of the hour. In this age of globalization, the societal attitudes towards education have gone through radical changes. Today higher education has become a commercial enterprise and is being treated as a marketable commodity. Many countries and universities throughout the world are preparing for marketing their education products and services in India. Day by day the competition from foreign universities is mounting up. So, education sector has been selected for this case study representing the service sector. Six Sigma is a set of methodologies used by businesses to achieve extremely low failure rates in any process. Similarly it can be used to achieve excellence in the field of education by improving the overall performance of the students. Education being a service industry where clients are the students and the quality of learning they achieve is the service. It can be presumed that student is the ‘product’, which an education institute ‘sells’ to the future employer.

Education has multiplying effects on all facets of development in a society and among various educational resources; engineering education holds the key to economic viability of a nation (Ho and Wearn 1995). All over the world, engineering education has been intensified in universities during the past four decades. On this front, India has also formally recognized the importance of higher education on science and technology and committed itself to the development of science and technology manpower by providing full policy support and substantial public funds to create one of the world's largest network systems of higher education system (Naik 2004). In engineering education sector during last few years, the number of self financed colleges has increased at an alarming rate, thereby causing acute shortage of faculty. Most of these colleges have been established with commercial motives and less emphasis is being given to quality of the education being imparted. To monitor the quality of technical education the process of accreditation has been introduced. NBA (National board of accreditation) under AICTE (All India council of technical education) has been constituted to do accreditation process. But NBA concentrates more on the system development and overlooks the aspect of customer satisfaction as a means of evaluating the quality level (Ahuja, 2004). In engineering education sector, there are many stakeholders like students, managements, government, industries, parents etc. and this makes the system very complex. Since students are the primary stakeholders in the system and their primary objective is passing the final examinations to vie for gainful employment, so passing rate of students is being accepted as a parameter to evaluate these privately managed engineering institutions. Raised expectations by academicians, educationists, policy planners and the society have threatened the sustainability of these institutions in present competitive life. For understanding the gravity of the problem, a 'Chain of Causation' structure showing the vicious cycle of problems in the technical institutes has been prepared. On the basis of this structure the Six Sigma methodology can be easily linked to the passing rate of the students or more precisely the overall quality of education being imparted in any technical institute. However, a moot question arises that is passing rate an important factor that reflects the quality of a technical institute? The answer is – yes; it reflects the quality of any technical institute significantly, though there are many other factors also. But by increasing the passing rate of the students these factors can easily be dealt with. Figure 1 shows the chain of causation diagram showing various factors that directly or indirectly affect the quality standards of a technical institute.

In this scenario, technical education institutions require an innovative supporting tool which can help in improving the quality of education system. People in industries from manufacturing to service are witnessing the growth of a strategic continuous improvement concept called Six Sigma. In industry, a company may look at defects in its final manufactured products but in engineering education, defects can be related to loss of students (Ho *et al*, 2006). This study is an initiative to shows Six Sigma DMAIC (Define, Measure, Analyze, Improvement and Control) methodology in a technical education institute to increase the passing rate of students.

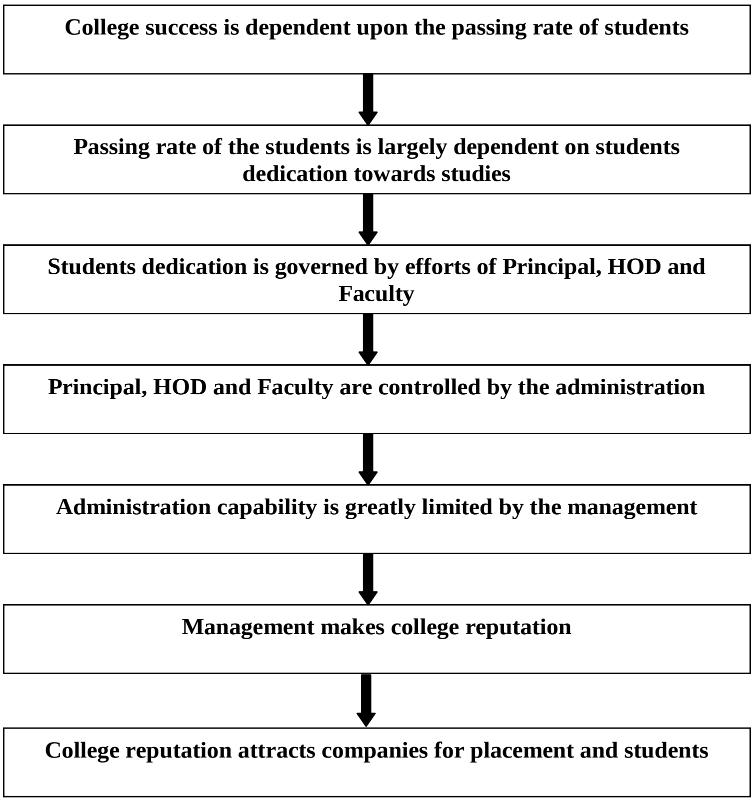

Figure 1 - Chain of Causation

2. Evolution of Six Sigma

In today's fast paced global economy market constraints are demanding that companies produce their product more quickly and with a better quality. The fast changing economic conditions such as global competition, customer's demand for high quality products had a major impact on organizations. Highest quality products and services were required to be offered at the lowest possible costs for maximizing customer satisfaction. Developers needed to create innovative complex products in lesser time. Six Sigma approach if applied prudently can meet these expectations of customers and organizations. Six Sigma as a measurement standard in product variation can be traced back to the 1920 when Walter Shewhart showed that three sigma from the mean is the point where a process requires correction (Pande et al., 2002). Motorola is the oft-cited creator of the formal Six Sigma methodology. Smith (1993) implies that Motorola first embarked on its Six Sigma quality initiative in the mid-1960s and the concept of implementing Six Sigma processes was pioneered at Motorola in the 1980s. Their approach was based on rigorous Japanese theories of TQM for use in the manufacturing process, where defects are relatively easy to spot and count and thus well suited to the high-volume, high precision electronics industry that has highly complex processes (De Feo, 1999). Motorola's specific involvement with Six Sigma began in 1982, when it implemented a quality-improvement program focused on manufacturing. Motorola's CEO asked his corporate managers to cut quality costs in half that year. He repeated the charge in 1983. By 1984, the cost reduction efforts were beginning to point to the need for improved analytical methods and product design for continued process improvement. The company's emphasis focused on design quality and a number of advanced quality tools were employed. It is no surprise that the first proponents of Six Sigma after Motorola were Texas Instruments, Allied Signal, Eastman Kodak, Borg-Warner Automotive, GenCorp, Navistar International and Siebe plc (Kumar, 2002). These forerunners of Six Sigma documented their discoveries and successes and, in the ensuing years, other companies followed their lead. While the original goal of Six Sigma was to focus on the manufacturing process, it became clear that the distribution, marketing and customer order processing functions also needed to focus on reaching Six Sigma quality standards and eliminating defects throughout the organization's processes**.** Motorola eventually developed its Six Sigma tools curriculum and created Six Sigma practitioner qualifications. These early efforts led the company to winning the Malcolm Baldrige Award in 1988 (Ho, and Wearn, 1995)

3. SIX SIGMA?

Sigma (σ) is a letter in the Greek alphabet that has become the statistical symbol, which is used in mathematics and statistics to define standard deviation. The sigma scale of measurement is perfectly correlated to such characteristics as defects-per-unit, parts-per-million defective, and the probability of a failure. Six is the number of sigma measured in a process, when the variation around the target is such that only 3.4 outputs out of one million are defects. Kumar and Sosnoski (2009) pointed out that Six Sigma methodologies have recently gained wide popularity because it has proved to be successful not only at improving quality but also at producing large cost savings along with those improvements. So, an organization needs to give smarter Six Sigma solutions that are linked to bottom line benefits. Park (2003) has stated that Six Sigma is a statistical measurement, which provides the opportunity and discipline to eliminate mistakes, improve morale, and save money. Doing things rightly and keeping them consistent are the basic ideas behind Six Sigma. A fundamental objective of Six Sigma is to achieve customer satisfaction with continuous improvement in processes. According to Harry and Schroeder (2000) CEO of Six Sigma Academy Phoenix, USA, Six Sigma is a well structured, disciplined, data driven methodology for eliminating defects, waste, or quality control problems of all kinds in manufacturing, service delivery, management and other business activities. O’Neill & Duvall

(2005) described that Six Sigma (6σ) is a disciplined quality improvement methodology that focuses on moving every process that touches the customers - every product and service - towards near perfect quality. Brue (2003) claim that Six Sigma developed towards a technology-based statistical process approach rather than a broad business improvement approach (Table 1) over the past ten years. They contend that this development has been driven by increasing global competitiveness, which has resulted in an:

- alignment of an organization around its processes; and
- increasing ratio of workers to managers by putting more authority into the hands of the people who do the work .

Table 1: The Six Sigma development challenge

Six Sigma as Statistical Measures	Six Sigma as Strategic Change
-Statistics theory and practice	-Management theory and practice
-Background in Statistical Process Control	-Background in People and Process Operation
-Defects measures	-Wide range of Measure
-Mechanistic	-Organic and Mechanistic

4. SIX SIGMA PROFESSIONALS: FROM INDUSTRY TO INSTITUTE

Six Sigma is not just about statistical tools and defect calculations, nor it is about having people work in teams. Teams alone cannot change corporate or educational structures. They must be part of an infrastructure designed to assist in the redesign of organizations, like scaffolding around a building being renovated. One way to understand this renovation structure is to review the role of people in the organization. For this purpose Six Sigma professionals in an organization came into existence. The first step towards the implementation of Six Sigma is to build a deployment platoon who is trained with varying levels of proficiency in the art of Six Sigma. The measure of proficiency on the tools of Six Sigma is denoted by the colour of one's belts as in the karate (Martial arts). The deployment platoon of Six Sigma consists of Champions, Master Black Belts (MBB), Black Belts (BB) and Green Belts (GB). These professionals have a single goal in mind from the inception of concept of Six Sigma 'to achieve the level of Six Sigma in minimum time span' (Ingle, 2001). The comparison between the duties performed by various Six Sigma professionals in industries and in technical institutes is as shown in table 2.

5. METHODOLOGY ADOPTED

The Six Sigma methodology employs various tools and techniques for its implementation. The various methodologies are DMAIC (Define-Measure-Analyze-Improve-Control), DMAC (Define-Measure-Analyze-Control), DMADV (Define-Measure-Analyze-Design-Verify) etc. But, the most popular technique among all these methodologies is DMAIC due to its versatile approach. It is somewhat similar to PDCA (Plan-Do-Check-Act) cycle. A team using DMAIC as shown in figure 1, which stands for define, measure, analyse, improve and control, undertakes the project. These are defined further as:

Table 2 – Equivalence between Six Sigma Professionals in Industries and in Institutes

SIX SIGMA PROFESSIONALS IN INDUSTRIES	SIX SIGMA PROFESSIONALS IN INSTITUTES
Leadership Group Council • Senior Managers – they plan and execute Six Sigma plan. • Their aim is to achieve Six Sigma in a planned way.	**Governing Body** • Members of Management/Management Committee • Proposes the Six Sigma plan to management
Project Sponsors and Champions • A senior manager with an experience in Six Sigma projects. • Accountable to leadership council for success of projects	**Principal/Head of Institute** • Sets up a goal for improving project • Finds resources for the team. • Advocates for the team efforts in management
Six Sigma Coach (Master Black Belt) • The Six Sigma coach provides expert advice to Six Sigma improvement teams. • He acts as a mentor and a trainer.	**Head of Departments** • Communicate with principal and management. • Deals with resistance to implement Six Sigma. • Help to resolve team and other conflicts • Gathers and analyses data about team activities.
Team Leader/Project Leader (Black	**Professor Incharge**

Belts) • The team leader accepts primary responsibility of result of Six Sigma project. • They are specified to one team only	• Reviews/revises/clarifies the project. • Works with team members. • Selects the project team members. • Identifies and finds resources for team • Documents final project results.
Team Members (Green Belts) • The team members bring the brain and measure for collection and analysis of data needed to improve the process.	**Student Advisory Committee** • Carries out instructions for data collection and analysis • Carries out assignments. • Reviews the efforts of the team itself. • Learns new data-driven ways to manage the operation
Process Owner • The process owner is normally the manager of a part of a particular function. • They receive solution created by an improvement team and become "owners" responsible for managing the improved process.	**Process Owner** • All faculty members and staff of the technical institute. • They are responsible for continuous improvement and maintenance of the same.

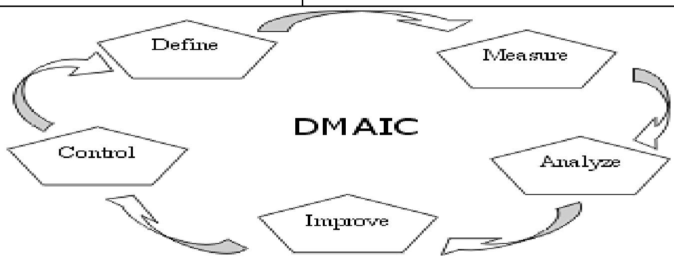

Figure 1; Six Sigma DMAIC technique.

The whole concept of Six Sigma DMAIC is discussed in detail as under:

5.1. Define:

This phase defines the project, and identifies critical customer requirements and links them with the business needs. It also defines the project charter and business processes to be undertaken for Six Sigma. In our case, the project is to improve the passing rate of the students in an institute.

5.2. Measure:

Identify the critical to quality (CTQs) characteristics of the process. This phase requires us to determine the factors that contribute to student attrition. To solve the problem defined, the factors that contribute to student’s attrition are determined. Many retention studies indicate factors such as financial aid, faculty students relations, curriculum and academic services etc that influence the passing rate. Once the CTQs are identified, surveys and interviews can be used to measure their effects on passing rate. This phase also involves the analysis of the process to determine its present state and the future, as obtained. Data collection is the main emphasis of this phase.

5.3. Analyze:

In this phase, data is analysed and the causes of the problem are discovered. Here, course of action is created to close the “gap” between how things work and how they should work to meet improvement goals. All root causes are analyzed and the most critical ones are fixed for improvements. In this phase, process capability analysis is done to find out the actual state of the process. The existing DPMO (Defects per million opportunities) or PPM (Parts per million) level which is the way to calculate the sigma level or yield of a process is determine using process capability analysis. Minitab software is used for analysis the data and it generates a process capability report, which includes a capability histogram overlaid with normal curve and the complete tables of capability statistics. After knowing the DPMO and sigma level of the process using process capability analysis, a fishbone or cause and effect diagram is to be prepared.

In the present case, a survey will be conducted among the students on the basis of collection opinion method. This is the most appropriate way of finding the Key Critical Factors (KCF) of a technical institute which directly or indirectly affects the passing rate of the students. The procedure followed is enumerated:

- As we have found the key critical factors of the institute so we are opting for the student system. Being students this would be most appropriate for us.
- The student performance will be adjudged in the most important fields.
- A survey will be conducted among the students to categorize the degree of importance of various fields.
- Some key performance areas will be located in sub-systems and assigned weight age according to the importance.

After this a Bar chart will be prepared, which is a pictorial representation of a data over a period or under different heads for a given period. Instantly, it gives the areas, which need immediate attention, and presents the relative comparison of the data between different heads. It is a simple and effective tool of data presentation, which helps to focus on the components of the problem that have the biggest impact. For making bar chart, actual weightage of each key performance area, assigned by the senior students during survey will be calculated and based upon these results, bar chart will be drawn.

5.4. Improve:

Improve the process to remove cause of defects. The optimal solution for reducing mean and variation is determined and confirmed in improve phase. The gains from the improve phase are immediate and are corrective in nature. Specific problem identified during analysis are attended in improve phase. This phase involves improving process performance characteristics for achieving desired results and goals. In this particular case, the improvement state can be achieved if the passing rate of the students starts increasing in the forthcoming years with the application of Six Sigma**.**

5.5. Control:

This phase requires the process conditions to be properly documented and monitored through statistical process control methods. After achieving the desired level of Sigma in the retention stage of DMAIRC cycle, there is a continuous control of the process.

6. CONCLUSION

The authors juxtapose a relationship between the applications of Six Sigma in corporations and in higher education. In industry, a company may look at defects in its final manufactured products. In engineering education, it can relate those defects as a loss of students. A higher passing rate of students in education will increase graduation rates and possibly more revenue for a college. With the increase of more engineering graduates, Six Sigma may provide a philosophy to meet the diversity needs of industry. With improved customer satisfaction, in academics a institute can have more involved alumni to help in recruiting more students. A simplified presentation of Six Sigma DMAIC methodology in technical institute is illustrated in this paper. The preliminary results from our environments reveal a need for better faculty, promising infrastructure, more financial aid, improvement in student faculty relationship and curricula. A faculty team plans to develop and implement further actions to address these issues over the next three years. Hence, the objective is to increase the passing rate of the students currently enrolled, increase graduation rates, and the result is a more efficient process of producing well-qualified engineers to meet the technological needs of our nation.

REFERENCES

1. Ahuja, I.P.S (2004), Strategies for affecting quality improvement in technical education', The journal of technical education, 27, pp. 56-63.
2. Brue, G. (2003), Six Sigma for managers, Tata McGraw hill, Fourth edition, Delhi.
3. De feo, J.A (1999), Six Sigma: Road map for survival, HRFOCUS, 76, pp. 11.
4. Harry, M. and Schroeder, R. (2000), Six Sigma: The breakthrough management strategy revolutionizing the worlds top corporations, Double Day- a division of random house publication, First edition, February 2000.
5. Ho, S.K. and Wearn, K. (1995), A TQM model for higher education and training', Training for quality 3, pp.25–33.
6. Ho, S.K. and Wearn, K. (1995), A TQM model for higher education and training, Training for quality, 3, pp.25–33.
7. Kumar, P. (2002), Six Sigma in manufacturing, Productivity journal, 43, pp. 197-201.
8. Kumar, S. and Sosnoski, M. (2009), Using DMAIC Six Sigma systematically improve shop floor production quality and costs, International journal of productivity and performance management, 58, pp. 254-273.
9. Naik,, B.M. (2004), Technological innovation in education institutes', The journal of technical education, 27, pp. 59-61.
10. O'Neill, M. and Duvall, C. (2005), A Six Sigma quality approach to workplace evaluation, Journal of facilities management, 3, pp.240–253.
11. Pande, S.P., Neuman, P.R. and Cavanagh, R.R. (2002), The Six Sigma way–team field book, McGraw hill, New York.
12. Pandey, A. (2007), Strategically focused training in Six Sigma way: a case study, Journal of european industrial training, 31, pp.145–162.
13. Park, S.P. (2003), Practical questions in implementing Six Sigma, Productivity news, July-August 2003, pp. 16-21.
14. Su, C., Chiang, T. and Chang, C. (2006), Improving service quality by capitalizing on an integrated lean Six sigma methodology, International journal of Six sigma and competitive advantage, 2, pp. 01-22.