APPLICATION OF SIX SIGMA DMAIC METHODOLOGY IN TECHNICAL EDUCATION

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Abstract
Quality technical education is the need of the hour. With the opening of more and more engineering colleges in the country the quality of technical education has degraded up to a great extent. This paper aims to applying, Six Sigma DMAIC approach, to increase the passing rate 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. An attempt has been made to visualize these aspects by taking into account the student’s eye view of a technical institute. Preliminary study shows that application of Six Sigma can prove to be a boon for such institutions.

Key Words: Six Sigma, DMAIC, DPMO, CTQ

1.0 Introduction
Technical education plays a significant role for economic progress and development of any country. The increasing demand for qualified technical man hour has led to an unplanned expansion of the technical education system with around 3000 and above institutions offering technical education in country today at different levels. Education being a service industry, service delivered at a cost, the definition of product and process has to be done carefully. The inferior quality of education being imparted in most of private technical institutes has drastically decreased the passing rate of students. The discouraging results have led many research scholars to suggest a possible methodology which can withstand the pressure of increasing the passing rate in such colleges. In this paper, serious attempt has been made to apply Six Sigma as a tool in a Technical Institute to increase the passing rate of the students. Contrary to previous studies the results are quite encouraging. The tools used in this case , are process oriented and examines attrition variables such as lack of financial aid, lack of tutoring support services, in conducive environment for learning, low peer and faculty expectations and inadequate preparation of engineering studies.

2.0 Origin of Six Sigma
Six Sigma originated as the quality improvement approach in 1980’s with a goal of improving quality of products, goods and services. It was pioneered by Bill Smith, CEO, Motorola in 1986. Further the concept bloomed when Motorola publicized the success of Six Sigma in 1995; Allied Signals was one of the first companies to grab the concept of Six Sigma. Allied Signal is reported to have saved $ 175 million in bottom line revenues in 1990 itself. However the final push to this movement was achieved when Mr. Jack Welch made Six Sigma a religion at GE. In India, Wipro was the pioneer in implementing Six Sigma. In 1998-99, in its first year of implementing Six Sigma, Wipro recorded savings of Rs 4.40 Crores. Other Indian companies soon joined the band wagon. Maruti Udyog started a Six Sigma pilot –project in its spare department in early 2000.

3.0 What is Six Sigma?
Sigma (the lower case Greek letter 6) is used to represent standard deviation (a measure of variation). Sigma is a high performance, data drawn method for improving quality by removing defects and there their causes in business process activities. Critically it concentrates on those outputs that are important to customers. It focuses on root cause of business problem to reduce variation (spread) of occurrences around the mean value of the process data. As the sigma level increases the variation of the process decreases and product reliability goes up, the need for testing and inspection diminishes, work in progress, cost and cycle time falls. Six is the number of
Sigma measured in the process, when the variation around the target is such that only 3.4 defects outputs of one million.

According to Bill Smith, the father of Six Sigma defined that “Six Sigma is a business philosophy of driving behavior by making an organization’s value explicit in its compensating system and a business strategy of cutting cost and boosting customer satisfaction. Tomkins (1997) defines Six Sigma as “a programme aimed at near-elimination of defects from every product, process and transaction”. Harry (1998) defines that Six Sigma is “a strategic initiative to boost profitability, increase market share and improve customer satisfaction through statistical tools that can lead to breakthrough quantum gains in quality”.

4.0 Comparison between Six Sigma Professionals in Industries and Technical Education

Six Sigma is not just about statistical tools and defect calculations. Nor is it just 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 evolving Six Sigma organization. For this purpose Six Sigma professionals in an organization came into existence. 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”. The comparison between the duties performed by various Six Sigma professionals in organizations as shown in table 1.

5.0 Why Six Sigma?

During the past half of the century more than 60 quality related activities have come into existence Statistical Process Control, Quality Circle, Total Quality Management (TQM), Quality Management System (QMS), ISO 9000 quality management system standard and other such activities have created a visible impact in the world quality professionals. Six Sigma provides a scientific and statistical basis for quality assessment for all processes through measurement of quality level. The six sigma method allows comparison among all processes and tells how good the process is. Six Sigma is regarded as the fresh quality management strategy which can be replacing TQM, TQC, ISO and others. Six sigma is viewed as a systematic and scientific approach for management innovation by the integration various elements such as customer, process, manpower and strategy. The CEOs of many world class companies visualized and foresighted the flaws of almost all the management philosophies. Thus, they created an approach to fix all the issues related to all these methodologies. Ultimately, Six Sigma was born.

Some of the advantages of Six Sigma which makes it a versatile approach are:

- Six Sigma extends the use of the improvement tools to cost, cycle time, and business issues.
- Six Sigma discards the majority of the quality toolkit. It keeps a subset of tools that range from the basic to the advanced. Six Sigma discards esoteric statistical tools and completely ignores such staples of the quality professionals as ISO 9000 and the Malcolm bladridge criteria. Training focuses on using the tools to achieve tangible business results, not on theory.
- Six Sigma integrates the goals of organization as a whole into the improvement effort. Six Sigma creates top-level oversight to assure that the interests of the entire organization are considered.
- Six sigma strives of world class performance. The six sigma standard is 3.4 PPM failures per million opportunities. Six Sigma creates an infrastructure of change agents who are not employed in the quality department. These people work full-time and part-time on projects in their areas or in other areas. Six Sigma for two years and then continue their careers elsewhere. Green belts work on Six Sigma projects while holding down other jobs. these subject matter experts are provided with training to give the skills they need to improve processes. Six Sigma “belts” are not certified unless they can demonstrate that they have effectively used the approach to benefit customers, shareholders, and employees.
Table 1: Comparison between Six Sigma professional in Industries and technical education

<table>
<thead>
<tr>
<th>PROFESSIONALS IN INDUSTRY</th>
<th>PROFESSIONALS IN EDUCATION</th>
</tr>
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<tbody>
<tr>
<td><strong>LEADERSHIP GROUP COUNCIL</strong></td>
<td><strong>DEAN/MANAGEMENT REPRESENTATIVE</strong></td>
</tr>
<tr>
<td>• Senior managers—they plan and execute Six Sigma plan</td>
<td>• Member of Management / Management Committee,</td>
</tr>
<tr>
<td>• Their aim is to achieve Six Sigma in a planned way</td>
<td>• Proposes the Six Sigma plan to management</td>
</tr>
<tr>
<td><strong>PROJECT SPONSOR AND CHAMPIONS</strong></td>
<td><strong>PRINCIPAL</strong></td>
</tr>
<tr>
<td>• A senior manager with an experience in Six Sigma projects. Accountable to leadership.</td>
<td>• Sets up a goal for improving project.</td>
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<tr>
<td>• Council for success of projects</td>
<td>• Coaches and approves changes in team charter</td>
</tr>
<tr>
<td><strong>SIX SIGMA COACH(AKA MASTER BLACK BELT)</strong></td>
<td><strong>HOD’S</strong></td>
</tr>
<tr>
<td>• The Six Sigma coach provides expert advice to Six Sigma improvement teams</td>
<td>• Communicates with principal and management</td>
</tr>
<tr>
<td>• They act as a mentor and trainer</td>
<td>• Deals with resistance to implement Six Sigma</td>
</tr>
<tr>
<td>• Council for success of projects</td>
<td>• Helps to resolve team and other conflicts</td>
</tr>
<tr>
<td><strong>TEAM LEADER/PROJECT LEADER(AKA BLACK BELT)</strong></td>
<td><strong>PROFESSOR INCHARGE/CHAIRPERSON</strong></td>
</tr>
<tr>
<td>• The team leader accepts primary responsibility of results of Six Sigma project</td>
<td>• Reviews/revises/clarifies the project</td>
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<td>• They are specified to one team only</td>
<td>• Works with team members</td>
</tr>
<tr>
<td><strong>TEAM MEMBERS(AKA GREEN BELTS)</strong></td>
<td><strong>STUDENT ADVISORY COMMITTEE</strong></td>
</tr>
<tr>
<td>The team members bring the brain and measure for collection and analysis of data needed to improve the process</td>
<td>• Carries out instructions for data collection and analysis</td>
</tr>
<tr>
<td><strong>PROCESS OWNER</strong></td>
<td><strong>PROCESS OWNER</strong></td>
</tr>
<tr>
<td>• The process owner is normally the manager of a part of a particular function.</td>
<td>• All faculty members, HODs and staff of the technical institute</td>
</tr>
<tr>
<td>• They receive solution created by an improvement team and become the “owners” responsible for managing the improved process.</td>
<td>• They are responsible for continuous improvement and maintenance of the same</td>
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6.0 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:
The whole concept of Six Sigma DMAIC is discussed in detail as under:

**6.1 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 a technical institute.

**6.2 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.

**6.3 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.
6.4 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.

6.5 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 DMAIC cycle, there is a continuous control of the process.

7.0 Conclusion

The goal of Six Sigma has produced many positive results for many world class companies. 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