Total Quality Management in Higher Technical Education

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Abstract – **The goal of this project is to analyse the Indian Higher Technical Education system through Total Quality Management techniques and tools. Our concentration is on our college DTU, where we study existing TQM methods and compare it with the remaining 6 other colleges in Delhi. The different methods used in this project gave us an idea about the quality standards in our college and how it lacks in comparison to other colleges.**
We discuss our findings, including any limitations and hence provide potential solutions to improve those lacking. We used different charts, ranking systems, and many more to compare the colleges. At last, we also highlight the future scope inside the field of TQM and how we can use those quality management tools on a bigger landscape in the education system. In addition, the roles of leadership in driving the implementation and adaptation of TQM procedures cannot be overstated.

Index Terms – **Critical Success Factors, Delhi Technological University, Higher Technical Education, Total Quality Management**

I. INTRODUCTION

TQM refer to a detailed and systematic system of organizational administration that aims at enhancing the quality of products and services through continued improvement in relation to continuous feedback. Initially devised for manufacturing and industrial environments, TQM has been effectively transformed into different areas of service industry, such as education.

TQM in higher education follows the same key ideas as in business—putting customers first, getting everyone involved focusing on processes using a complete system, planning always getting better making choices based on facts, and talking well.

This involves getting teachers and staff to join quality groups setting clear goals for performance, and making choices based on facts and figures. It gives a sense of authority to the people in the schools and colleges to ensure that right quality is being served to the students by making sure that rules, courses, and services align with the main goal of providing top-notch education.

One of the fundamental components of TQM in higher education is continuous improvement, often operationalized through tools like PDCA cycles. In technical institutes, where curricula should keep pace with rapid technological developments, the ongoing improvement is very essential to ensure that programs remain relevant and effective.

A. QUALITY IN TERMS OF EDUCATION

Quality in case of education refers to the extent to which the learning process makes students develop, acquire skills and grow. It also considers how it meets groups like students, employers, teachers, society, and decision makers' expectations. For higher technical education, quality is mostly related to aspects like good teaching graduate job readiness, good course material, good academics, contributions in research, and the institution's facilities.

We will now look at quality in education through the view of customer satisfaction, which is a major principle of TQM where students are seen as the main customers of education, but employers, industries, parents, and the larger society also play significant roles as stakeholders. To ensure quality, institutions must match their outcomes with what stakeholders expect. For example, industries want graduates who are prepared for jobs and equipped with both hands-on knowledge and communication skills. This means that schools should keep on updating their curriculums to align with the new technologies and trends in the global industry.

To sum up, education quality in higher technical institutions involves more than just facilities or resources. It takes a broader shape touching on relevance, efficiency, equity, effectiveness, and meeting the expectations of stakeholders.

B. VARIATION BETWEEN QUALITY OF GOODS AND SERVICES

Quality is a catch-all term, and it varies significantly when used to characterize goods and services grounded on their nature and variety. It must be known that this variation exists for Total Quality Management (TQM) to be put in place in the higher technical education, which is a service sector.

Due to the dynamic and intangible in nature, quality maintenance is difficult in service-oriented processes such as education. TQM education emphasizes individual-oriented methodologies, continuous feedback, process standardization, and involvement of students. SERVQUAL (service quality measurement model), Kaizen, and continuous feedback mechanisms are the main tools through which the quality of services can be controlled. In short, where product quality can be regulated by tight specifications and tests, service quality like in high-tech education requires emphasis on consistency, responsiveness, customization, and continuous improvement. An understanding of this distinction allows institutes to adapt their quality management practice accordingly.

C. DEFINITION OF QUALITY AND ITS IMPORTANCE

In technical education, the concept of quality surpasses classroom teaching and examination performance. Therefore, it is the entire educational ecosystem—from curriculum design, pedagogy, faculty competence, infrastructure, industry linkages, student support systems, research avenues, administration, till the satisfaction, and success of all parties involved. With global standards in education being on a rise constantly, the assurance of quality has, therefore, become of unmistakable priority to excellence realization, recognition, and relevance of any institute.

Quality, in broader terms, stands for "fitness for purpose," by which one means, conformance to requirements. In technical education, this implies that the educational processes and outcomes should conform to the laid-down objectives of imparting knowledge, skill, and application of knowledge set by industries and society at large

D. EDUCATION SCENARIO IN INDIA

India holds one of the biggest and most varied education systems in the world serving more than 260 million students. Year by year, its education system has undergone tremendous changes across domains such as assess and inclusion and expansion. However, quality and consistency remain notable issues when addressing higher technical education. Although the number of institutions has increased, the quality of education, infrastructure, and employability have not improved at par. India is placed with the third largest higher education system in the world after the United States and China. The country has over 1,100 universities and 45,000 independent colleges and institutions.

A significant number of these focus on teaching technical subjects like engineering, IT, and applied sciences. To maintain and improve quality in technical education, organizations such as the AICTE, the NBA, and the NIRF play a key role.

II. NATIONAL SCHEMES IMPLEMENTED FOR QUALITY IMPROVEMENT

In India, various national initiatives have been started to improve the quality of education. These initiatives are focused towards enhancing the research output and the overall infrastructure, as well as the academic standards of the institutes. One of these initiatives taken is the NIRF, which is initiated by the Ministry of Education to ranks institutes based on different parameters. This initiative requests institutes to increase performance to become nationally recognized.

To improve the quality or faculty, the Faculty Development Program was established to educate and enhance the proficiency of instructors in the new pedagogical methods and practices of industry. This program is essential for ensuring that faculty members are equipped to impart high-quality education.

Additionally, the Institution of Eminence (IoE) scheme seeks to help select higher education institutions achieve global recognition and excellence by providing them autonomy and increased funding.

In addition, the National Skill Development Corporation collaborates with educational institutions to enhance skill-based education and training to prepare graduates for industry. In terms of research promotion, the Impacting Research Innovation and Technology and Technical Education Quality Improvement Programme are critical schemes supporting research and innovation at higher technical institutions.

III. CRITICAL SUCCESS FACTORS

There are numerous substantial matters that capture your concentration in business that it is often difficult to identify the things that really matter for success. What is more, it can be insanely challenging to get everyone in the team driving in the same path and targeting on the true essentials. That is where Critical Success Factors (CSF) comes into the picture. CSFs are those vital areas of exercise that must be carried out well if you want to accomplish your goal, target or aim for your business or project. Top managements advocacy is vital to confirm the availability of detailed actions. According to Saraph et al., the activities can be taken to organize the divisional top management and quality policy, provide a quality management structure, captivate a whole staff, publicize information on quality, process management operating quality and systematize the day of quality.

Critical Success Factors used here –
1. Teaching, Learning & Resources (TLR)
2. Graduation Outcomes
3. Research Output
4. Perception (PR)
5. Infrastructure Quality
6. Faculty Quality and Competence
7. Student Satisfaction and Feedback
8. Alumni Network & Institute-Industry Linkages
9. Placement & Career Support

A. STATISTICAL PROCESS CONTROL CHARTS
SPC helps manage and improve quality by using statistics to monitor and control processes. One important tool in SPC is the Individuals Chart (I-Chart), which plays a huge role in this project itself. It is important when you need to track processes where measurements come one at a time rather than in batches or samples. An I-Chart includes:
1. X-axis (Time or Sequence) Values: Shows the order in which the data points are gathered and presented.
2. Y-axis Values: Shows the real measurement of the characteristic being observed.
3. Center Line (CL): Displays the average of all the data points.
4. Upper and Lower Control Limits (UCL and LCL): These are statistical limits. They sit around 3 standard deviations above and below the mean to show usual variation in the process.

IV. RESEARCH METHODOLOGY

In order to compare 7 colleges in Delhi, the strategy is to assess quality management in these colleges. This will enable us to know where they are lacking and where they are strong so that they can strengthen weak areas and build on strengths. The steps involved here are listed below:

1. Research Design
• This research compares and describes findings.
• The study aims to assess how six Delhi colleges perform in nine key areas to find what sets them apart as well as their strong and weak points.

2. Selecting the Sample
• Random selection is used in this project.
• 7 Delhi colleges were selected on the basis of relevance and reputation.

3. Finding Critical Success Factors (CSFs)
• These factors can be compiled by reading studies and other publications.
• CSFs used in the project: Teaching and Learning, Graduation Performance, Research Work, Reputation and Public Perception, Infrastructure Standards, Faculty Skills and Expertise, Student Experiences and Opinions, Alumni Engagement with Industry, and Career Opportunities including Placements.

4. Collecting Data
The data can be gathered from sources like official websites of these colleges, datasets and scores from NAAC and NIRF annual institutional summaries, accreditation reports educational portals like Shiksha.com or College Dunia, statistics on doctoral scholars, student admission data, magazines, and rankings released in the public.

5. Techniques to Analyze Data
• Comparing how colleges perform across the given 9 factors using charts and rating tools.
• Spot areas of strengths, and weaknesses.

6. Spotting Weak Points
Spotting where colleges fall short when compared to other colleges and figuring out methods to address and improve those weak points.

A. TOOLS AND METHODS USED
There are various techniques which have been utilized to compare the CSFs of different colleges which include:

a) I chart which is a statistical process control chart
b) Rating systems (out of 10) whose inputs are relative and based after the normalization of all factors taken in each CSF
c) Some other charts like Radar Charts, Correlation Heatmaps, Bubble Charts, Gantt Charts, Cause and Effect Matrix are also used for this comparison

After all the comparison has been completed, these tools have been used for improvement:
a) Ishikawa Diagram   d) Pareto Analysis
b) Kaizen   e) Benchmarking
c) PDCA Charts

ISHIKAWA DIAGRAM

This diagram is also known as a Fishbone Diagram, which is used to determine the causes of a specific issue. Developed by Kaoru Ishikawa, this tool enables teams to analyse and structure the fundamental causes of a problem by examining various associated factors. In higher education for example when student placement rates drop, using an Ishikawa Diagram will help identify issues like gaps in curriculum, faculty expertise, student readiness, or lack of industry partnerships. This organized and structured way to analyse problems allow teams to make smart, data-backed decisions. It keeps improvements on track and matches standards such as ISO or TQM guidelines.

Basic cause and effect diagram
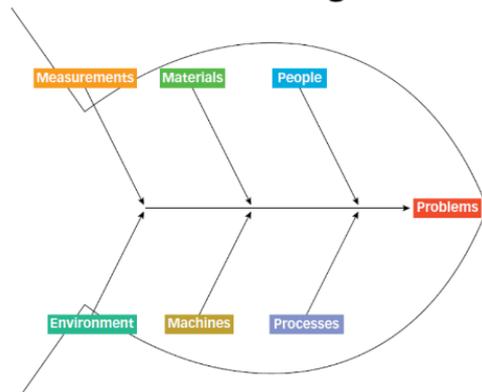
KAIZEN

Kaizen, which is a Japanese concept for "continuous improvement," focuses on small steady changes to make processes smoother more efficient, and better overall. In quality management, Kaizen involves everyone in the organization—leaders and workers alike—in building a culture where improving never stops.

PDCA CHARTS

The PDCA cycle—Plan, Do, Check, Act—is a simple model for ongoing quality improvement in quality management systems. Created by Walter A. Shewhart and popularized by W. Edwards Deming, PDCA is widely applied both in industry and education to improve processes in a systematic way. In higher technical education, the PDCA cycle can be a powerful tool to ensure quality at all levels, from curriculum development to institutional governance.

PARETO ANALYSIS

Pareto Analysis, or what many call the 80/20 Rule, helps with decision-making by focusing on the main factors that influence results. The idea comes from Vilfredo Pareto, an economist from Italy, who noticed that around 80% of effects come from just 20% of causes.

The chart does play a key role in quality management. It helps institutes aim their efforts at the most important issues that make a major difference. Instead of spending time on every problem, this analysis encourages educators and leaders to "focus on the vital few, not the trivial many."

BENCHMARKING

Benchmarking is a methodical process of comparing an institute's performance, practices, or processes with those of the leading universities in the world

which will give us an idea about the gaps and hence we can make improvements. This tool is a central quality management tool which allows higher technical education institutes to learn from the best practices and improve their academic and administrative performances.

B. TQM GOAL AND TQM CSF

Total Quality Management often called TQM, uses a structured way to manage organizations. It works to make products and services better by making constant improvements based on regular feedback. Everything focuses on keeping customers happy to achieve long-term success, and quality ideas get applied in all processes within the organization.

Schools and colleges use TQM to boost how well students perform academically, improve how administrations run, increase student satisfaction, and build a stronger reputation for the institution.

In order to attain TQM, organisations must pay attention to some CSFs. These factors help them in achieving their major quality objectives. 9 major CSFs were identified in this article to assess and study the performance of these 7 colleges.

1. Teaching, Learning, and Resources (TLR):
   This considers the quality of teaching practices, the qualifications of professors, the ratio of students to teachers, and the availability of study materials and facilities. It reflects how each college prioritizes sharing knowledge and keeping students involved through good teaching practices and adequate facilities.

2. Graduation Outcomes:
   These measures how students do in finishing their degrees going for higher education, or clearing key exams. It shows how a college helps its students graduate and prepares them to take the next step in their careers.

3. Research Output:
   This considers research that a college produces, such as published work, patents, and funded research. It reviews the college's contribution to intellectual achievement and scientific discovery and confirms the quality and utility of its output.

4. Perception (PR):
   This reflects how people like students, graduates, employers, and academics view the college. It shows the institution's reputation and image, which influences student choices and what employers look for.

5. Infrastructure Quality:
   This examines the state of things like labs, libraries, hostels, and internet services. These give a clear idea of the resources and environment colleges offer to help students learn.

6. Faculty Quality and Competence:
   This criterion considers how qualified and experienced that profs are, as well as their involvement in research, training programs or publications.

7. Student Satisfaction and Feedback:
   This factor gathers what the student find in terms of the teaching materials, courses, facilities, and their general experience at the college.

8. Alumni Network and Institute-Industry Links:
   This touch upon how alumni remain connected with the college and work with industries through internships, guest lectures, or joint projects.

9. Placement and Career Guidance:
   This element looks at the job placement percentages, salaries offered, and career counselling services provided. It provides an idea how the college assist their students in finding their desired jobs and future plannings after graduation.

V. COMPARATIVE ANALYSIS

Now, in this project, DTU has been compared to six different colleges based in Delhi namely – IIT Delhi, IIIT Delhi, NSUT Delhi, Jamia Milia Islamia, SRCC and Lady Shri Ram College.

So, here is a table based on comparison between the 7 different colleges based on 9 different CSFs:

College	Teaching Learning & Resourc	Graduation Outcomes (GO)	Research Output (RPC)	Perception (PR)	Infrastructure Quality	Faculty Quality & Competence	Student Satisfaction & Feedback	Alumni Network & Institute-	Placement & Career Support

	es (TLR)							Industry Linkages	
IIT Delhi	8.6	8.5	9.2	9.9	9.0	9.0	9.0	9.5	9.5
DTU	7.3	7.6	4.4	4.9	7.5	7.0	8.0	7.5	8.0
NSUT	7.2	7.5	2.6	2.3	7.0	6.5	7.5	7.0	7.5
IIIT Delhi	5.4	7.2	3.2	1.8	7.0	8.5	8.0	7.5	8.5
SRCC	6.5	9.0	3.0	9.0	8.0	8.0	9.0	9.0	8.5
Lady Shri Ram	6.0	9.4	2.9	10.0	8.0	8.5	9.5	9.0	8.5
Jamia Milia	6.6	7.5	5.9	1.9	7.0	7.5	8.0	7.0	7.5

Now, the ratings are based are normalized and relative in nature based on different sources:

For example,

1. Teaching, Learning & Resources (TLR), Graduation Outcomes (GO), Research Output (RPC), and Perception (PR): These statistics are directly taken from the NIRF 2024 rankings.

2. Infrastructure Quality: This statistic entails the examination of institutional reports and campus reviews which includes various sources such as Shiksha.com, College Dunia etc.

3. Faculty Quality & Competence: This criterion can be assessed keeping in mind faculty credentials, student-faculty ratio, and research inputs, based on institutional profiles and NIRF parameters which provided insights into PhD holders at these institutions.

For example, IIIT Delhi has 104 faculty in total with approx. 55% having earned their PhD degrees.
IIT Delhi boasts more than 650 teaching faculty with around 99.82% holding PhD degrees from premier institutions across the globe.

4. Student Satisfaction & Feedback: Statistics collected through surveys, feedback, and comments found on online learning platforms, forums, and reviews.

5. Alumni Network & Institute- Industry Linkages: Assessed based on LinkedIn Alumni pages, NIRF Innovation metrics, Online Start Up Rankings, Official placement brochures etc

For Instance, IIT Delhi alumni are founders of big companies like Zomato, Flipkart, Delhivery.

IIIT Delhi show strong industry linkages due to its research driven projects using AI, cyber security tie-ups.

DTU possesses a strong alumni base and long-standing industry relevance with multiple unicorns etc

6. Placement & Career Support: This rating is done after gathering data from placement statistics, median salary packages, and career support services, referencing placement reports and institutional data.

For Instance, this factor includes taking Placement Rates, Median CTCs, Top Recruiters etc. into consideration for analysis.

Also, no of BTech, MTech, PhD, Diploma students in each of these institutions can give us the idea about the research outcomes and overall development.

For instance, in IIT Delhi there are 4971 undergrads, 3568 postgrads and 4000+ doctoral students.

In DTU, there are 7000+ undergrads, 900 approx. postgrads, 390+ doctoral students.

In Jamia, there are 9000+ undergrads, 5000+ postgrads and 1600+ doctoral students.

Now, we will use the Statistical Process Chart which is an I-Chart to analyze the colleges in 9 different CSFs which will give a clear picture and understanding:
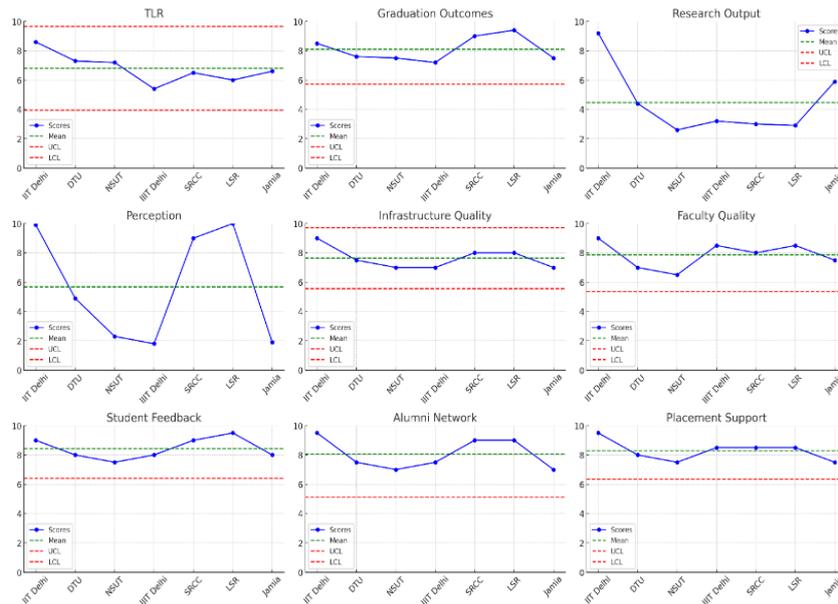
Some Key insights based on these control charts include:

1. IIT Delhi is a college which is consistently outperforming everyone in almost all the dimensions, which shows its well-balanced institutional profile.

2. SRCC and LSR, though they are not tech institutes, but perform exceptionally high win graduation outcomes, perception, and student feedback, which highlights their excellence in commerce and arts.

3. DTU and NSIT (NSUT) are those colleges which does offer strong engineering programs but lack in research and perception when compared to IIT Delhi.

4. IIIT Delhi does has high placement and faculty quality but it needs to improve in research and perception where they lack.

5. Jamia display inconsistencies across categories, which indicates there are areas for strategic improvement.

Here are few more charts which have been used to compare these colleges:
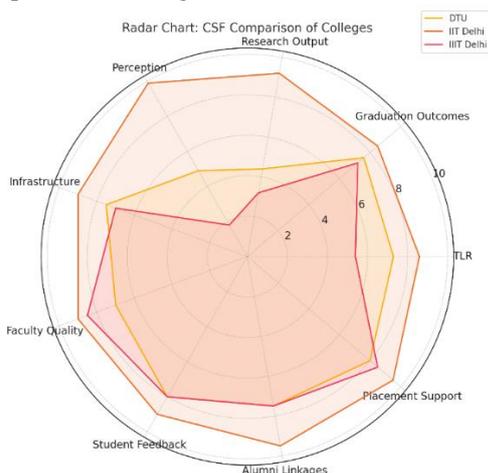
The first chart uses Radar charts to show how IIT Delhi, IIIT Delhi, and DTU stack up against each other on nine CSFs. It shows where each college stands on different factors. IIT Delhi leads in areas like Research Output and Perception, while DTU and IIIT Delhi lag.

The second chart depicts a SWOT Table. This table points out strengths and weaknesses within DTU, along with opportunities it can use and threats it might face.

The third diagram includes a Correlation Heatmap. This heatmap highlights connections between things like Research Output, Faculty Quality, and Placement rates.

The fourth chart uses a Control Chart to track the research work happening at each college. IIT Delhi shows up as an exception, while DTU sits below the average.

The fifth chart shows a Gantt Chart which lays out the schedule of Kaizen tasks like updating courses and running training programs.

The sixth chart displays a Bubble Chart which matches Graduation Outcomes with Placements. The bubble size shows Research Output.

Additional Visualizations for TQM-Based College Comparison

The seventh chart uses a Cause-and-Effect Diagram to list major reasons that are responsible for slowing down the research at DTU.

The eighth chart shows a Benchmarking Bar Chart which puts DTU and IIT Delhi side by side in three key areas.

VI. CONCLUSION

Drawing on an extensive comparative study of seven leading institutions of higher education in Delhi, the report concludes that Total Quality Management techniques have the potential to become effective tools to determine strengths, loopholes, and areas for improvement in technical education. Delhi Technological University though dominant in alumni networks and placement assistance, falls short in research output and reputation in comparison to IIT Delhi, which is the top performer in all parameters considered. Non-technical colleges SRCC and Lady Shri Ram College exhibited impressive results in student satisfaction and perception, indicating that excellence does not lie solely in technical areas. Tools like SPC charts, Ishikawa diagrams, PDCA cycles, Kaizen, Pareto analysis, and benchmarking have been successfully used to propose tailored improvement strategies to each institution. The research affirms the need for leadership commitment, teacher development, outcome-based education, and active stakeholder participation to enhance quality in higher education. It also offers a strong framework to implement TQM practices combined with national accreditation processes like NAAC and NBA. Subsequent endeavors can expand this study b y employing machine learning software to predict trends, including environmental quality indicators, and promoting collective improvement cycles within institutions. In the end, embracing TQM throughout the educational system not only enhances institutional performance but also makes graduates more prepared for the needs of global industry and life-long learning in an increasingly dynamic world.

VII. APPENDIX

APPENDIX A: COLLEGE COMPARISON RAW DATA TABLE
APPENDIX B: SPC CHARTS
APPENDIX C: RATING SYSTEM JUSTIFICATION
APPENDIX D: ISHIKAWA DIAGRAM
APPENDIX E: PDCA AND KAIZEN ACTION PLANDS
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Figure 5	Radar Chart
Figure 6	SWOT Chart/Table
Figure 7	Correlation Heatmap
Figure 8	Control Chart
Figure 9	Gantt Chart
Figure 10	Bubble Chart
Figure 11	Benchmarking Bar Chart

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