8. ENGINEERING EDUCATION - PRESENT SCENARIO AND NEED FOR RESEARCH -

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Abstract

This study concentrates on engineering education in the sub continental part of the fast developing Asian country , India . The study helps in finding out the perception of education stakeholders about the quality in engineering education. It is proposed to validate or otherwise, the following hypotheses. The hypotheses are

1. Student feed back about the education process contributes significantly towards enhancing the quality of education

2. A clear mission, objective and commitment of the management towards satisfaction of the stakeholders in the institute is necessary to improve the quality of education in the institute

3. Research Development and Training activities through faculty development programs goes a long way towards enhancing quality of education

Real time data has been collected from different engineering colleges of one of the states of the fast developing country, India. The data is from 10 colleges with different background based on location, age and students' gender. Results indicate the factors responsible for governing the quality of education and the perception of stakeholders about the same.

Key Words: *Engineering Education, Total Quality Management, Process Approach, Statistical Tools, Correlation and Regression*

1. Introduction

Engineering is the profession in which knowledge of mathematical and natural sciences, gained by study, experience and practice is applied with judgment to develop ways to utilize economically the materials and forces of nature for the benefit of mankind. Engineers turn ideas into reality; they create useful products and systems through playing with imagination and possibilities, leading to new and meaningful connections and outcomes while interacting with ideas, people and environment.

Role of engineers has been broadened, nowadays, to cover aspects of organizational competitiveness. Macro-engineering awareness is perceived to be the element of their education/ training which will enable them to understand how large systems operate including people processes, machine

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processes, market behaviors, suppliers etc. Educational establishment needs to redesign the curricula and are required to be more innovative in providing skills according to the industry demand. The concept of stakeholders under Total Quality Management umbrella, is influencing most educational establishments supplying engineering - skills to industry. Engineering graduates today require not only adequate technological ability and problem solving skills, but must also be endowed with soft skills like co-operative working, communication and presentation skills, business ethics, inter-personal relationship, and posses a deep commitment to safety, reliability, quality and sustainability of all the engineering activities.

The rapidity of technological obsolescence is compelling the education system to ensure that students during their stay in the institution develop an attitude for life long learning and acquire self-learning skills. Continuous learning is an essential part in any quality engineering education system.[1].

After 1950, there has been a phenomenal growth in higher education in terms of quantity. From thirty universities, 591 colleges, 21,244 teachers and 2,28,300 students enrolled in 1947 -48, today the country has more than 294 universities, 13,150 affiliated colleges, 4,27,000 teachers, and a student strength of 88,21,000. This unprecedented increase in numbers in last 50 years, coupled with unmatched increase in infrastructure, has led to compromise in standards, quality and excellence. [2].

However, a rapid growth of engineering education has created a serious problem regarding quality of teachers, infrastructure facilities and appropriate learning environment. This brings to focus the necessity to have a system ensuring quality, its measurement and implementation. The present studies are basically directed towards identification of the factors affecting the quality in engineering education and its implementation and continual improvement.

Methodology and Theory Framework

This methodology applied and the theory used for framing the work with detailing and analyzing data collection, treatment and comparison and verification of the hypotheses laid down by the researcher, to measure the quality of Engineering Education in some of the Engineering colleges coming under one of the University. To clarify and establish objectives for the hypothesis designed, the study covers definitions and identification of stakeholders of Engineering Education system and enlists their expectations from the system based on proven experiences and traditional mind-set. To verify the extent to which these expectations of stakeholders are fulfilled, a detailed feedback process, based on questionnaire, is conceived and designed. The random sample selection criterion has been applied for choosing the participants in the feedback process.

The issue of quality assuarance in higher education has been at the top of the agenda of universities / institutions throughout the world. Many countries aim at creating a common higher education area, within which universal standards and programme structures to achieve an internationlisation of education, are formulated. In today's environment, given the international competition for the students, staff, faculty and resources, all universities and institutions need to constantaly improve their quality standards to maintain quality standing by demonstrating cost of poor quality. Present study proposes to find the link at different stages of education process specifically at input , process and output level, which will wide open the doors for understanding of quality management in educational sector.

The researcher has used self administered questionnaire and structured interviews to collect data from personnel in addition to data collection from 10 engineering colleges of different standing based on age, location, only for girls and co-ed etc. and analysed these with statistical tools to find correlation between different factors of education process. The

stratification of colleges was necessary to get all inclusive picture.

The documentation and the records, speak about the numbers, which in turn, can be useful for analysis and inferences for the further improvement of the process. Statistical concepts and statistical tools have become a global trendsetter in developing quality management strategy. The success is primarily due to its data based approach, which eliminates personal bias. Statistical techniques are a pack of tools in the repertoire of any decision maker to arrive at rational decisions. Since statistical concept is based on data, the quality of the data assumes paramount importance. Statistical law of regularity says, if the data comes from a set controlled conditions, the data will exhibit a predictable pattern called statistical models. [3]

Tree Diagram Model: A tree diagram model [4] is useful for identifying the tasks and the factors involved in the main process. It is beneficial in solving complicated problems and achieving the objective in a systematic way. A tree diagram drawn for Factors involved in the Engineering education process is shown in the Figure 1.

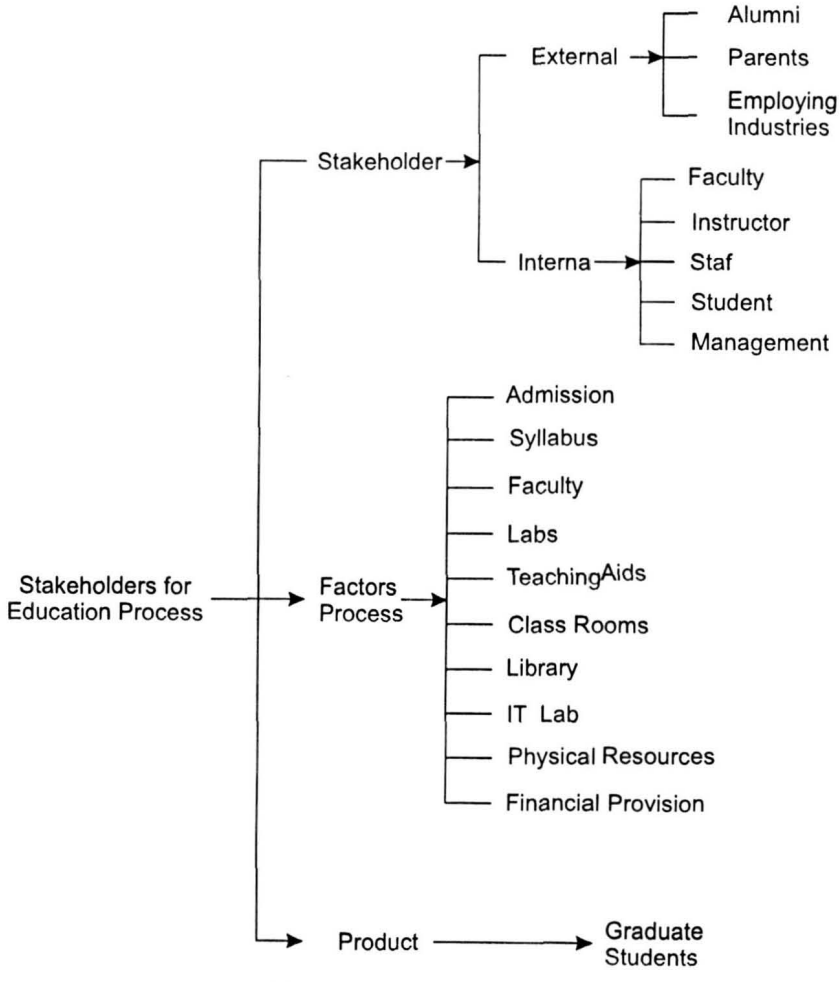

Figure 1 Tree Diagram Model

3. Process Approach for Engineering Education

The study of Figure 3.1 gives fair idea about engineering education in simple manner. Engineering education activity has process input, process output and the main teaching learning process. Factors involved and the stakeholders connected to these processes and the sub-processes are shown in Figure 2 which also illustrates the education process by using analytical tool known as 'Cause and Effect diagram'.[5]

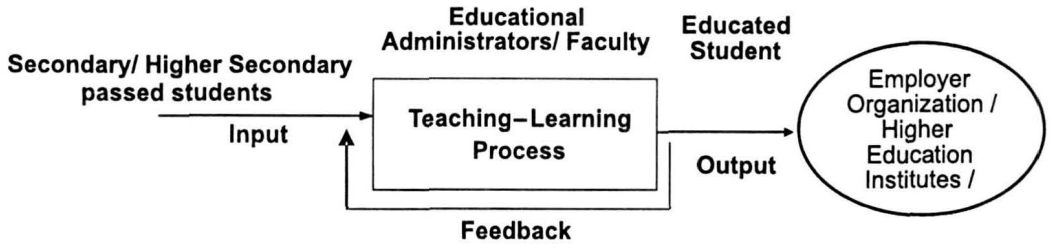

Figure 2 Engineering Education Process

4. Identification of Education Process Stake Holders [6]

While studying factors involved in engineering education process with the help of Tree Diagram Model, the important stake holders of the education process are identified and are shown in Figure 3.

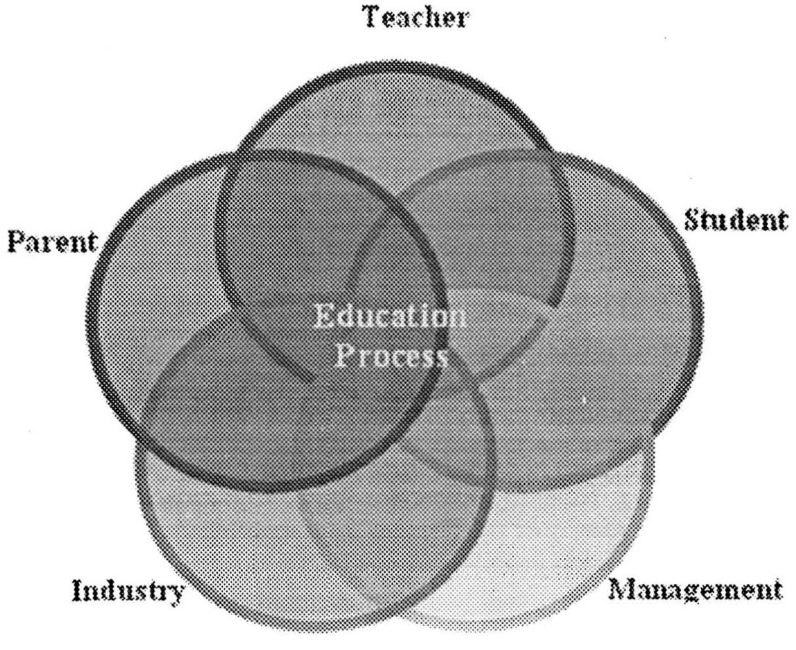

Figure 3 Stakeholders of the Education process

Student: Since every education system should and must be student or learner centric. The *Student* has been identified to be the first stakeholder of the Engineering Education system. He or she is the living entity who is the beneficiary or the loser, can be an idol or a culprit, can impact and get affected by policies and decisions executed in the system. The student is the first and foremost evaluator to decide quality, values and ethics in the system and therefore, is the most prioritized element to accept or reject any model of education in the hierarchy of the Engineering Education system.

Teacher: The teaching learning process should be, and is, a dialog or interaction, between students and teacher. Since teacher is an equally respectable personality in the Indian culture at par with the parents, the second hierarchical stakeholder of Technical Education system is the *Teacher*. The teacher is responsible for shaping and molding the personality and future of the student. Whether he enters the profession by choice or by accident, he orients himself with the traditional practices followed in the teaching learning process; sometimes innovates styles, tries to remain a learner throughout and contributes to the society as an individual.

Management: The Management or administrator of Engineering Education Institute / College, may be private or Government, are identified as the third stakeholder. They are the major resource generation agencies, which facilitate the whole teaching learning process with required inputs. They are the entities which responded in time to the privatization policy of the Government, sensed the need of the time and acted with vision to share the responsibility.

The above three stake holders are an integral part of the institution and may be described as 'internal stakeholders'.

Industry: The student is the final outcome or a live product of the teaching-learning process in Engineering Education System. Industry at large is a buyer of this product; it renders a finishing touch to this human resource (HR), making it more competent and skilled. With the involvement of such HR, industry contributes to the overall economic development of the country, along with Agriculture and lifts the living standards of the citizens. We, therefore, consider *Industry* as the next stakeholder of Engineering Education system.

Parents: In India, unlike in western countries, because of the highly bonded family structure, parents feel themselves responsible for educating their wards. The type of education, which can bring materialistic and mental happiness to the children, therefore, becomes the choice of the majority of the families. Also the concept of student financing his own education is very rarely seen in the society. The parents are payers or financers to the Engineering Education system in most of the cases. We, therefore, consider Parents as another important stakeholder of Engineering Education system.

The above two stake holders are not a part of the institution but are interested in the institute and its final product. They may be defined as 'external stake holders'.

Finally, it is the society at large which tastes the fruits of the up-liftment in whatever aspect is affected due to technical education system. In a civilized culture, an educated person should exhibit a sense of social obligation. He / she should behave as a responsible citizen who repays directly or indirectly to the society. Development of an individual results in societal progress, which in turn, links to national development. The actions and activities of all the above-identified stakeholders have finally an impact on the society. Therefore, indirectly, Society is also a stakeholder of Technical Education System.

5. Research Methodology

After identifying the stakeholders in the

Engineering Education system and their expectations, the following research methodology is adopted to study the measurement of quality in undergraduate Engineering Education. A detailed questionnaire has been administered for each stakeholder, based on his or her mentality, philosophy and expectations.

Philosophy of Questionnaire Design

We explain below the thought process or the philosophy of the stakeholder that was sensed by the researcher in his interaction throughout his professional tenure. Since every stakeholder has his own place or layer in the hierarchy of engineering education system, the design of the question set stake-holder-wise has minute reflections as human being or a system entity. The questions are broadly related to the academic side of engineering education system.

Since, we have been stressing upon the thought that every education system must be learner-centric, a large number of questions have been designed in the questionnaire for the students. This element of the system has emotional concerns with many other elements like teacher, his teaching style, the evaluation process, the infrastructure facilities, the placement opportunities etc. The questionnaire surely includes all these aspects.

5.1 Design of Questionnaire for the Stakeholders (Student, Teacher, Management, Industry and Parent)

A distinct and exclusive question-set is designed for each stakeholder. Every question set has about 20 to 25 questions whose answers are sometimes objective, sometimes multiple-choice types, sometimes just assertive or negative. Sometimes, the stakeholders are requested to express their opinion in their own words.

5.2 Data Acquisition

The set of questionnaire is handed over to respective stakeholders personally with brief information of the objective. The filled in questionnaires have been collected through personal visits or through courier. The soft copy of the questionnaire was circulated through internet and intranet of different colleges taken for study and the answers received are expected to reflect the perception of the stakeholder with honesty and faith. The whole feedback process to be executed through this question set is implemented by a random sample base technique.

5.3 Factors Responsible for the Quality of Engineering Education

Factors identified and taken for studying quality of engineering education are

- Management, Leadership, Mission and Goal
- Teaching process- faculty, students, teaching and learning process
- Physical resource- Library, IT lab, work-shop, other related labs
- Industry and Institute linkage
- Research and Development

While identifying the above factors and forming questionnaire, the following two major inputs have been considered as guidelines as given in Table 1 [7, 8]

- National Committee for Technical Education has set the norms for effective operations of Degree level engineering educational institutions/colleges
- National Board of Accreditation has set the guidelines for assessment of Quality in education.

Factors	Maximum Score
Management, Leadership, Mission, Goal	300
Teaching process – Faculty, Student, Teaching learning process	450
Physical reso urce - Finance and physical resource like IT, Library, Labs etc	100
Industry and institute linkage	100
Research and development	50
Total Score	**1000**

Table 1 Factors Identified for Framing Questionnaire with Respective Score

The purpose of determining a questionnaire is to know precisely how to increase stakeholders' level of satisfaction by finding weak service areas and suggesting about service area where improvement is desirable. First, a pilot response has been tried out to know the reliability and validity of the questionnaire, which we found satisfactory and readers understood it while giving the answers. Then the questionnaires were distributed to all the stake holders.

Stratified sampling is used, in selection of 10 colleges under the university, for collection of data and data analysis. Stratification is done based on location of the college, age of the college and boys/girls or co-ed college also whether the college is from rural or urban area. The information on selection of colleges based on stratification factors has been given in Table 2.

The names of the colleges have been withheld to maintain confidentiality.

More than 600 samples were collected for processing and this sample size has been checked and validated by using Chi Square statistical test. This test is useful in analyzing more than two populations. This test has shown that the sample is representative as the value of chi-square is in the acceptance limits of Chi Square distribution. [9]

5.4 Analysis of Data and Reporting

Stakeholders' satisfaction and the perception about the education process is drawn with the help of questionnaire in the following manner.

- Send the questionnaire to various stakeholders.

Classification Of the colleges
Colleges from Urban with 25years age **College 1,2,3**
Colleges from Rural and Urban with 10 to 15 years age **College 4,5,6,7**
Colleges less than 10 years age (newly opened) **College 8,9**
College 10 Branded college

Table 2 Selection and Classification of the Colleges

- Solicit their response.
- Study the results.
- Find the areas of strength and weakness.
- Devise a tool for the performance measurement of the institute.

A questionnaire is prepared comprising on an average 20 criteria to assess education process quality. These 20 criteria are grouped into five service quality dimensions to determine stake holder's perception of education rendered by the institution.

The questionnaires were sent in the order shown in Table 3, to stakeholders, to solicit their response. The responses received in numbers from different stakeholders are shown in Table 3.6.

Tools used Analysis [10]

The correlation and regression analysis are important statistical tools to determine the degree of the relationship and nature of the relationship. The regression analysis enables us to predict the value of the dependent variable from the value of the associated independent variable.

Multiple Regressions

In simple linear regression, a relationship between two variables is examined.

In order to examine the relationship of overall satisfaction with many other factors within the survey, **Multiple Regression Analysis** is used to examine all factors simultaneously in their prediction of overall satisfaction.

This allows us to determine which variable or variables best predict overall customer satisfaction.

Analysis of data obtained has been carried out by using analytical tools listed below (11, 12)

- Cause and Effect diagram-Analytical tool
- Process mapping
- Tree Diagram-Data collection analysis and display method -
- Brand name/Bench marking - management methods
- Service Quality Dimensions
- Likert response scale
- Statistical Random Sampling
- Stratified sampling
- Gap Analysis by Area chart
- Radar Diagrams
- Linear Regression
- Multiple Regressions
- ANOVA - Analysis of Variance.

Institute / Stakeholder	1	2	3	4	5	6	7	8	9	10
Students	30	30	30	30	30	30	30	30	30	30
Teachers	15	15	15	15	15	15	15	15	15	15
Management	05	05	05	05	05	05	05	05	05	05
Industry	05	05	05	05	05	05	05	05	05	05
Parents	05	05	05	05	05	05	05	05	05	05

Table 3 Questionnaire response from stakeholders

The above tools have been applied by using software Microsoft Excel 2002, Microcal Origin version 3.5 and Minitab 11.21... Data worked out for college 1 has been given below. Similar data has been worked out for other colleges for which please refer Table 10.

Data Analysis for College 1

This institute is with more than 25 years of age situated in urban area and giving education to both boys and girls. Data analysis has been carried out for this institute on the basis of the results obtained from different stakeholders and details of analysis has been given below.

Physical Resource (100 points)

The procedure adopted for calculating score of each factor is based on the average score of each factor .

The overall average response was obtained, for the Physical Resource factor; the detailed scores are given along with the average of all stakeholders in Table 4 for college 1.

Stake Holders / College	Student	Teachers	Management	AVG
1	60.79	88	53.96	67.58

Table 4 Overall Responses for Physical Resource

Management Leadership (300 points)

The detailed scores are given along with the average of all stakeholders in Table 5 for college 1.

Stakeholders / College	Student	Teachers	Management	Parents	Industry	AVG
1	249	239	207	161	132	198

Table 5 Overall Responses for Management Leadership

Teaching Process (450 points)

The detailed scores are given along with the average of all stakeholders in Table 6 for college 1.

Stakeholders / College	Student	Teachers	Management	Parents	Industry	AVG
1	372	353	376	249	221	314

Table 6 Overall Responses for Teaching Process

Institute – Stakeholder linkage (100 points)

The detailed scores are given along with the average of all stakeholders in Table 7 for college 1.

Stakeholders / College	Student	Management	Parents	Industry	AVG
1	80	100	42	53	68

Table 7 Overall Responses for Teaching Process

College 1 Research & Development (50 points)

The detailed scores are given along with the average of all stakeholders in Table 8 for college 1.

Stakeholders / College	Student	Teacher	Industry	Management	AVG
1	35	20	20	17	23

Table 8 Overall Responses for Research & Development

General Observation Based on Analysis

The following general observations as shown in Table 9 may be made based on data presented for College 1.

Institute No	Information of the Institute	Observation
1	25 years age and located in urban area	**Strength** ● I nstitute scored above average in all factors ● Teaching process is stabilized and Institute ensures faculty feedback from students to improve the education process ● Institute stakeholder linkage is good. ● Leadership through vision and mission **Weakness-** R & D activity is weak

Table 9 General Observation for College 1

Assessment of the Quality of engineering education and the gap analysis has been done by using **Radar Diagram** and **Area Chart**. [13, 14]

Radar diagram and Area Chart

These are the graphical tools for showing relative strength and weakness of activities. This is useful when the aim is to involve people in evaluating key areas of business and in organizing where things could be improved and for showing changes for items measured on a Likert Scale. The related work has been done and carried out with the help of Microsoft Excel software module. [15, 16]

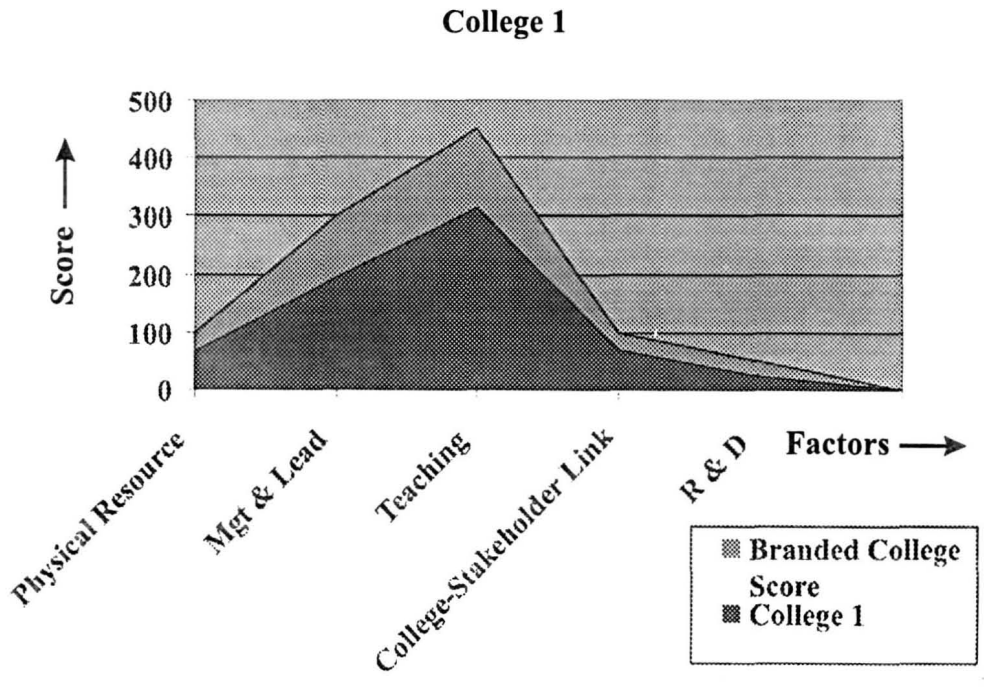

Figure 4: Area chart to show Factor wise score of college 1 with reference to branded college (refer Table 10)

For Area Chart in Figure 4, X axis represents the 5 factors identified and taken for measurement and Y axis represents the score points obtained by each of these factors ranging from 0 to 500. Two different colors have been used to read the gap for each factor between Branded College and college 1. The message of the figure is self evident.

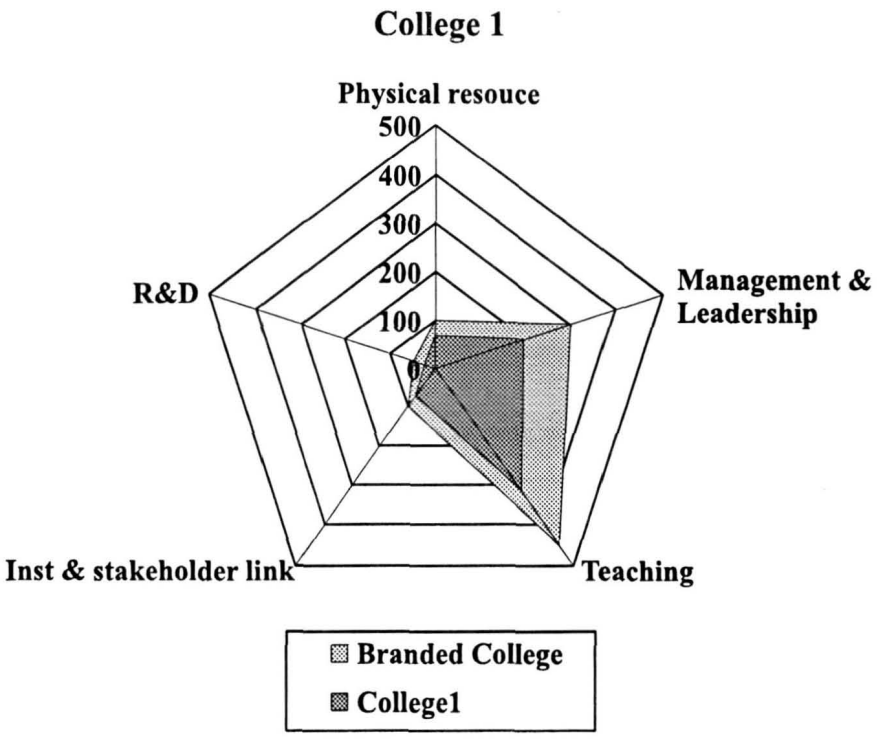

Figure 5: Radar diagram to show Factor wise score of college 1 with reference to branded college (refer Table 10)

For Radar Diagram in Figure 5 the corner points of the pentagon are representing 5 factors identified and taken for measurement and the radar is constructed for the score points obtained by each of these factors ranging from 0 to 500. Two different colors have been used to read the gap for each factor between Branded College and college1.The message of the figure is self evident.

5.5 Factor wise Input From Different Stakeholders and Gap Analysis for Each Factor for All Colleges, 1-10

The calculations given in previous sections for the factors of each one of the colleges have been given on the basis of input from different stake holders. The input obtained for each factor with the individual average scores of all the ten colleges including Branded College have been shown in the comprehensive Table 10 given below along with the Total Score.

Factor / College	Physical Resources	Mgt. & Leadership	Teaching Process	Institute Stakeholder Linkage	Research & Development	Total Score
Max. Points	**100**	**300**	**450**	**100**	**50**	**1000**
Branded	**92.7**	**266**	**408**	**91**	**45**	**903**
1	67	197	314	68	23	669
2	86	235	376	76	35	808
3	81	210	345	86	34	753
4	56	145	265	58	10	534
5	58	165	240	56	12	531
6	43	110	194	41	10	398
7	47	117	190	43	10	407
8	63	190	320	64	15	652
9	68	184	315	56	15	638

Table 10: A comprehensive table showing score of each factor

It will be seen from the data that College 6 and 7 have the lowest total score. Also all the colleges except Branded College do not either have any research programs or a very weak R & D activity. The data on R & D is not enough to validate hypothesis 3 based on research and development activity and therefore, the hypothesis can not be tested.

The above figures obtained in numbers gives us the difference in inputs from the stake holders. The histograms showing score for the 'Total Score' has been shown in Figure 6 which has provided good readability and understanding about the same. In the graph drawn, X axis represents nine colleges except the Branded College and the Y axis represents the respective total scores obtained for the colleges.

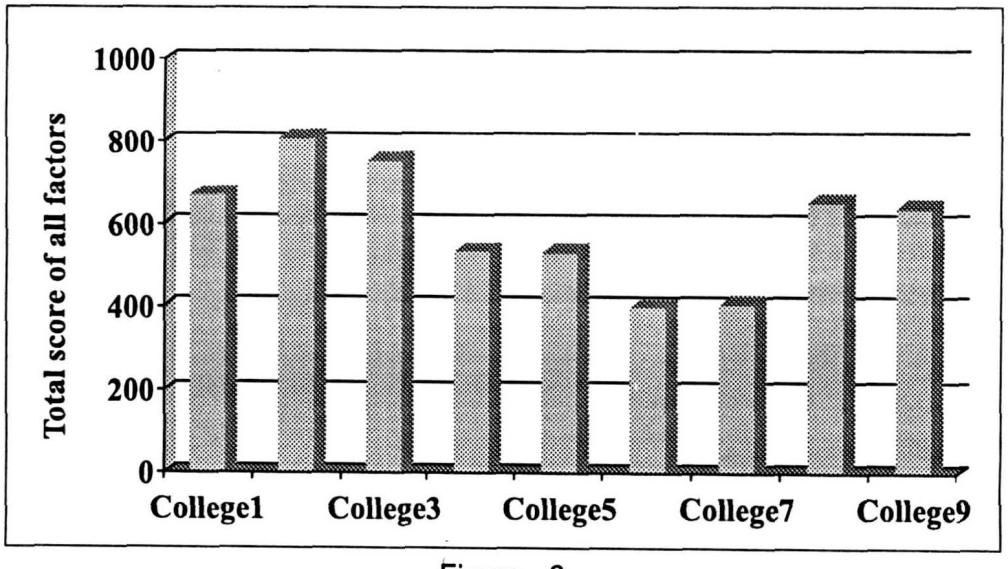

Figure - 6

Gap Analysis (Deviation) for Each College in Comparison to Branded College

Following are the figures which show % deviation for each of the colleges, for each factor responsible, for the enhancement of the quality of engineering education in comparison to Branded College. These figures are shown in Table 11

P % = Present score in % Dv % = Deviation in %

College	Physical resource		Management & Leadership		Teaching process		Institute Stakeholder Link		Research & Development	
	P %	Dv %	P %	Dv %	P %	Dv %	P %	Dv %	P %	Dv %
1	67.0	25.7	65.6	23	69.7	20.9	68	23	46	44
2	86.0	6.7	78.3	10.3	83.5	7.1	76	15	70	20
3	81.0	11.7	70.0	18.6	76.6	14.0	86	05	68	22
4	56.0	36.7	48.3	40.3	58.8	31.8	58	33	20	70
5	58.0	34.7	55.0	33.6	53.3	37.3	56	35	24	66
6	43.0	49.7	36.7	51.9	43.2	47.4	41	50	20	70
7	47.0	45.7	39.0	49.6	42.2	48.4	43	48	20	70
8	63.0	29.7	63.3	25.3	71.1	19.5	64	27	30	60
9	68.0	24.7	61.3	27.3	70.0	20.6	56	35	30	60
Branded	**92.7**	**-**	**88.6**	**-**	**90.6**	**-**	**91**	**-**	**90**	**-**

Leadership 11: Comprehensive Table showing Deviation for Each Factor

The data clearly shows that College 6 and 7 are lagging behind the most. Incidentally, these are the colleges situated in rural area.

5.6 Validation of Hypotheses [17]

Hypothesis 1

Student feed back about the education process contributes significantly towards enhancing the quality of education

Student feedback on teaching and learning process has been a regular activity for colleges 1, 2, and 3. Teaching process score obtained from stakeholders and students examination results are also good. The Table 12 below shows the total process score and students response on teaching process obtained for all colleges including Branded College.

College	Student's Response (X)	Total Process Score (Y)
1	375	669
2	415	808
3	320	753
4	280	534
5	260	531
6	200	398
7	190	407
8	390	652
9	380	638
Branded	**430**	**903**

Table 12: The Total Process Score and Students Response for the Teaching Process

The linear regression has been used to get the relation between two variables. The Figure 7 shows the result, where X axis represents students response obtained on teaching and learning process through feedback and Y axis represents total process score of the colleges.

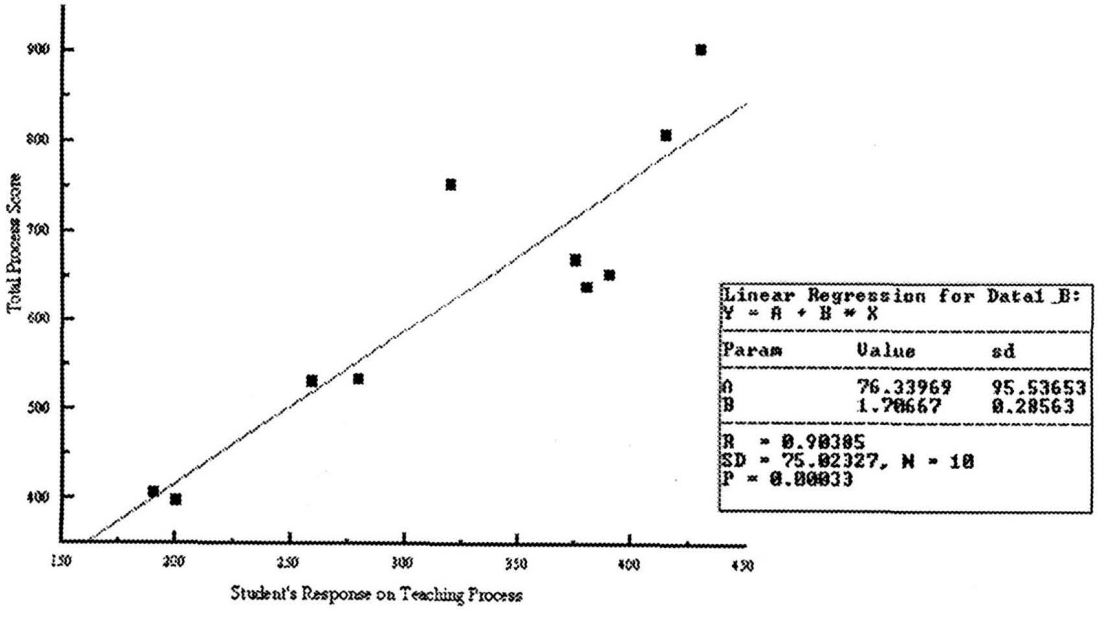

Figure 7 The graph of Process score v/s teaching – learning process response

Here , Y = A + B*X is the straight line equation where A represents intercept and B represents the slope of the line .The coefficient of correlation 'r' has been found out to be 0.90385 & coefficient of determination 'r2' is 0.81694. This shows a good and strong correlation between the two variables taken. The above two observations validate hypothesis 1.

Hypothesis 2

A clear mission, objective and commitment of the management towards satisfaction of the stakeholders in the institute is necessary to improve the quality of education in the institute

Newly opened colleges have better vision and mission for Enhancing quality of education as compared to colleges of the age of 15-20 years and colleges situated in rural area who were unaware of the importance of vision and mission. The Table 13 below shows the process score and Management-leadership response obtained for all 9 colleges and the Branded College.

College	Mgt. and Leadership Response (X)	Total Process Score (Y)
1	198	669
2	235	808
3	210	753
4	145	534
5	165	531
6	110	398
7	117	407
8	190	652
9	184	638
Branded	**266**	**903**

Table 13: The Total Process Score and Managment - Leadership Response

The linear regression has been used to get the relation between two variables. The graph is shown in Figure 8, where X axis represents Management-Leadership response obtained through feedback and Y axis represents total process score of the colleges.

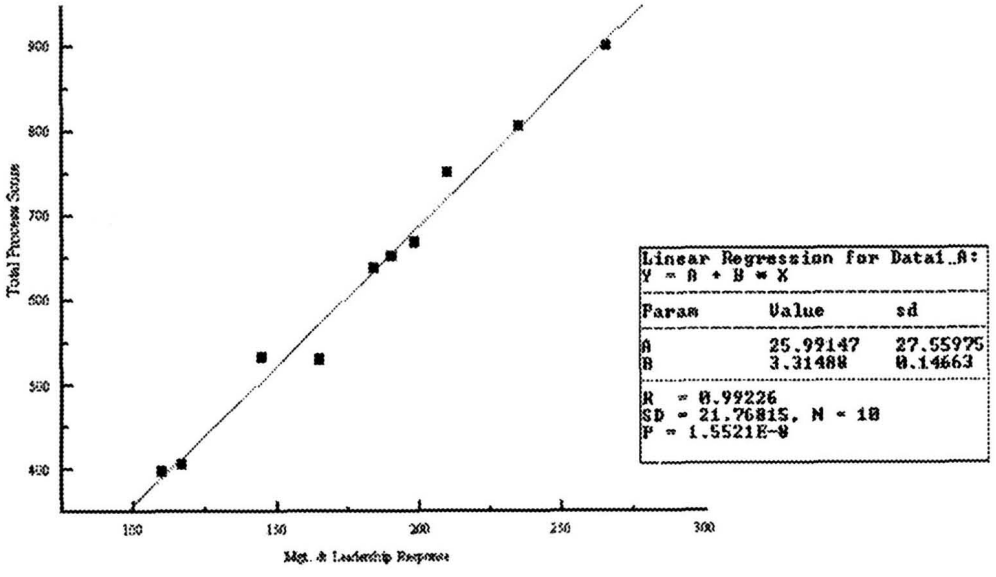

Figure 8 The Graph of Total Process Score v/s Management- Leadership Response

Here , Y = A + B*X is the straight line equation where A represents intercept and B represents the slope of the line .The coefficient of correlation 'r' has been found out to be 0.99226 & coefficient of determination 'r2' is 0.9845. This shows very good and strong correlation between the two variables and validate hypothesis 2.

Hypothesis 3

Research Development and Training activities through faculty development programs goes a long way towards enhancing quality of education

Research and Development activity has not received much attention in these colleges except the Branded College which is the government approved centre for the research and development activity. The feedback score obtained for research and development activity from different stakeholders is very low. In the absence of any worthwhile R & D activity it will be premature to validate hypothesis 4 in respect of the colleges investigated.

Prima face' the present investigator has no loyalty to any of the above hypotheses. Only data can validate the above hypothesis.

5.7 Inferences

Nine colleges were selected for detailed investigation. College with long experience , government funded and having very high perception by the society has been chosen as a Branded / Benchmark College. The selected colleges have been compared as regards Physical Resources, Management & Leadership, Teaching Process, Institute Shareholder Linkage and Research & Development with Branded College. The Branded College was also investigated in respect of all these factors, because being a high perception college, it has never been subjected to external audit. It turns out that the Branded College No. 10 has the highest scores in respect of all the factors and therefore the choice of the college as Benchmark College is justified.

Amongst other institutions, colleges having more than 25 years of experience have all their processes except R & D stabilized and they have very good total process score, however college 2 has relatively more score than college 1 and 3. College having age between 10 to 15 years located in urban area have scores in the intermediate range, however colleges having the same 10 to 15 years age but located in rural areas i.e. colleges 6 to 7 have poor scores as regards almost all the factors. This clearly indicates that rural based colleges have some inherent limitations and efforts should be made by the management to remove the deficiencies found in these colleges. None of the investigated colleges have any worthwhile research programs and these colleges are mainly concentrating on undergraduate teaching activity. All these colleges are required to pay more attention to Post Graduation Courses & R & D activity.

Relatively New Colleges having age between 5 to 10 years show good scores especially their teaching & learning process, which are comparable with colleges having age between 10 to 25 years. These colleges need to establish Post Graduate, Research Programs & strengthen their interaction with Industry & other Institutions. On the whole colleges located in urban area of the state are functioning reasonably well.

Correlations were sought between various parameters using well established statistical tools such as Linear & Multiple Regression analysis. Thus it may be observed that the students take into account the overall standing of the college as given by the total process score while taking admission. As far as response by stakeholders is concerned, it appears that the perception of students, teachers, and management whom we may describe as internal stakeholders is in general similar. Whereas industry and parents who may be described as external stakeholders appear

to have similar perceptions, which is less favorable than that of internal stakeholders. Probably the attachment of internal stakeholders of the college makes them give somewhat favorable scores.

6. Recommendations

1. It was found during the course of investigations, that Government funded colleges have never subjected themselves to audit by external agency. It is recommended that they should periodically carry out internal as well as external audit of their processes and performance. A suitable system such as Quality Cell should be established.

2. The multiple regression analysis carried out in present investigations defines Product Quality as the academic performance of the students in the course. However in these days of globalization, such a definition of Product Quality is not adequate, because to be employable a student must also have soft skills, personality and attitude. Unfortunately none of the education institutions have a system for measuring these traits in the students. Therefore it is recommended that a system of grading or marking the above traits be established in each and every college. The measurement of such traits should be quantifiable. The input regarding traits has been gathered through personal discussion with different stakeholders.

3. Every institute should also establish a Statistical Cell to continuously keep the data and upgrade & analyze it from time to time. This would help them in self evaluation. The data should cover feedback information about the overall education process including admission, teaching and learning, peer review, examination and industry employment etc.

4. The undergraduate degree program colleges are required to pay more attention to Post Graduation Courses and Research & Development activity. This will allow them to add new and latest technology based resources in the existing facility. This will help them in contributing and enhancing quality of engineering education.

7. Road Map for the Research Activity:

To think about research one should know that there are broadly two types of research activities, the one practical research and the other theoretical research. The first one require laboratory facility and testing and validation facility of the experimentations. Second one require through knowledge of statical and mathematical tests and its inferences. Study of different types of graphical solutions and its interpretation, institutions are required to work on the following points:-

1. Institutions to form a research committee within the organization which can promote the research activity and provide help to the people involved in the activity.

2. Institutions to encourage faculty members for taking up the small projects relevant to the field of their interest and should allow the final year students to work along with these faculty members as a project assistants. For this, due credit to be awarded to the students for the quantum of work involved in completion of the project.

3. Institutions to include 'Research Methodology' as a regular course in the curriculum at the third year level of engineering degree program for getting orientation about research activity.

4. Institutions to strengthen, the institute – industry interaction for the identification of the problems, research gap and plan the road map along with the industry to address the problems, research gap.

5. Educational Institutions to tie up with the research laboratories, leading industries in particular sector for interactions on the problems identified and the topics selected

for the research activity.

6. Education Stakeholders' feedback to be taken up as a part of the project to improve the education process and subsequently the same topic can be taken up as a research project depending on the expected value addition to the organizational work.

7. Top management and governing council of every institution should consists of the members having strong academic background with active interest in research activity, so that the facilities required for the research will get developed in the institution over the period of time.

8. Ethics of academic research need to be inculcated at faculty and student level to uphold the good image of the institution in the society.

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