

Key Factors Affecting the Effectiveness of Technical Education— An Indian Perspective

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Abstract— The competitiveness has come into educational field as well. The education Institutions today have also woken up to this reality of the market. In India, the phenomenon has now struck most institutions in general and Technical Institutions in particular.

The present study makes an attempt to enlist various factors that affect Technical Education and further develops a mathematical model to measure its effectiveness. The study is exploratory in nature and data has been taken up from Technical institutions affiliated to one Indian University.

Index Terms— Effectiveness, mathematical model, Technical Institution, TQM.

I. INTRODUCTION

India, in recent past has witnessed a number of reforms in Education sector with the adoption of free economy. However, these changes have affected the supply and demand and education quality. The concept of higher quality, lower cost of production and service are the emerging needs of today's customers (Joseph Rosiczkowski, 1993). This is a matter of great concern for today's education institutions that the products (students) are not meeting the initial prerequisite standards of industries. Hence it is very much necessary that the students which are coming out from engineering colleges must be directly useful for industries. In order to fulfill the primary motto of the institution, i.e. to impart high quality technical education it is imperative to maximize the effectiveness of the institution. And in order to improve the effectiveness of any institution the various factors affecting it should be identified and their importance in maximizing the effectiveness should be analyzed. The quantitative and qualitative analysis of these factors shall assist in framing the logical, relevant policies and strategic planning of the technical institutions. It is, therefore, attempted here: 1. to analyze need of TQM concept in technical education 2. Identify various factors affecting the effectiveness of technical institution 3. Study and critically evaluate the influence of each factor and improve the condition of these factors so that they have positive effect in improving the effectiveness by using mathematical model.

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II. LITERATURE REVIEW

A. *Quality in Education*

The quality is defined by British Standards Institution, 1978 as “The totality of features and characteristic of a product or service that bear on its ability to satisfy stated or implicit needs”.

Quality in Education can be defined as:

- the development of intellectual skills and knowledge that will equip graduates to contribute to society through productive and satisfying engineering careers as innovators, decision makers and leaders in the global economy (R. Natrajan, 1999)
- the ability of a product to satisfy the requirements of the customer (Roma Mitra et al., 2007) and quality in engineering education is an open system at various levels i.e. students, teachers, curriculum, institutional and state level (Kulkarni P.,1999)
- Quality depends on the institution infrastructure, faculty's research and development activities and industry-institution interaction etc. (Malleham P., 2005)

(Sangeeta Sahney et al., 2004, 2007) define Quality in education from TQM perspective. They believe educational institution as an open system i.e. management system, a technical system and social system.... It includes within it the quality of input in the form of students, faculty, supporting staff and infrastructure, the quality of processes in the form of the learning and teaching activity and the quality of outputs include examination results, employment, earning and satisfaction. Some more definition of TQM are given below-

- TQM is an integrative philosophy of management for continuously improving the quality of product and processes to achieve customer satisfaction (Mohanty & Lakhe, 1994)
- The main philosophies of TQM include customer focus, continuous improvement and process - orientation in teaching and learning process (Sitalakshmi Venkatraman, 2007).

B. *Need of Quality culture in Technical Education*

TQM is needed in Technical Institutions for the some of the following reasons:

1. To be growth oriented and have a good reputation
2. To be never out of market
3. To be capable of maintaining customer confidence.
4. To be cost effective.
5. To improve customer satisfaction and to develop confidence.

6. To use the creativity of faculty and students for development of the institution.
7. To provide careers to the faculty instead of jobs
8. To provide job satisfaction to all employees
9. To enhance healthy competition
10. To be an example to other institutions
11. To eliminate the waste of resources at all levels.

Growth of technical institution is largely based on quality system and creativity of every body. Quality of technical education normally has two important aspects

1. Design inbuilt quality- The design by curricular courses and course material, their structure should develop high class quality of graduate students who can meet the requirements of customers internal or external.
2. Manufactured quality – Graduate student should comply with a set of standards of the institution. The faculty involved in teaching is creative, innovative, qualified with up to date knowledge. The technical education should be comparable to international standard and must be cost effective.

C. FACTORS AFFECTING THE EFFECTIVENESS

In order to achieve the esteemed goal of producing well qualified and trained technocrats an institution has to work efficiently and effectively. Every technical institution strives towards imparting technical competence to the student by creating a healthy environment for their personality development and finally enabling them to achieve higher grades in their respective fields. Various input factors responsible for TQM in technical education are summarized in Table 1(Annexure-1).

The literature clearly indicates that there are various factors which directly or indirectly influence the effectiveness (Quality) in technical education. Here we group these factors under seven broad heads as discussed below

[A]	Administration
[B]	Infrastructure
[C]	Teaching Effectiveness
[D]	Students
[E]	Interaction with Industry and Society
[F]	Extra Curricular Activities
[G]	Research and Development

A. Administration [A]

The administration of technical institution play vital role in its functioning and its responsibilities includes-

1. Setting objectives for the functioning of the institution.
2. Formulating policies and programs to achieve it.
3. Controlling all the functions which directly or indirectly affect the efficiency.

B. Infrastructure [B]

“We shape our institution and our institution shapes us”, Winston Churchill. An institution must have adequate land, necessary buildings, hostels, supporting facilities, canteen, transport, library, well equipped laboratories and workshop

availabilities of teaching aids like OHP, LCD projector, seminar halls conference room and last but not lest advance computing facilities.

These facilities are initial prerequisite for any technical institution which must be present to ensure proper functioning of Technical Institution.

C. Teaching Effectiveness[C]

The quality of students coming out of the universities and colleges largely depends upon the quality of the teaching staff employed. The frontier of science and technology are doubling by leaps and bounds to cope with it its necessary, for the faculty to be constantly in touch with the same and try to update themselves through enhancing their qualifications attend various quality improvement programs like workshops, seminars, conference, summer and winter school etc. is the responsibility of the institution to provide a proper and conducive atmosphere for the teacher.

D. Students [D]

The students constitute the input of the whole system. The accomplishment of the process of imparting knowledge is greatly affected by environment in which the students are put and also on their self zeal to learn and excel. A student’s own awareness and interest for learning and the inherent aptitude to grasp together with his sincerity, regularity and honesty are key to his successful accomplishment of his course. It is also necessary to boost the moral of the students by motivating the students. All these aspects when carefully implemented and nurtured bring about a total turn around in the quality of education.

E. Interaction with Industry and Society [E]

The fresh engineers from technical institution need to be offered training in industries to give them first hand practical exposure. There is a need for general recasting of curricula, with industry oriented programs and to establish a close link between an educational program and social needs.

F. Extra Curricular Activities [F]

Good education in its totality must include the overall development of the student and must not restrict to training in a specialized discipline. The institution must organize various extra- curricular activities like arranging group discussions, debates, technical quizzes, extempore, guest lectures, seminars and promote NCC, NSS, sports, games, cultural and co-curricular activities. These extra curricular activities enhance and improve the inherent capabilities and skill of the students.

G. Research and Development [G]

Research and development activity is very much essential to survive in this competitive world. The institution must have proper infrastructure to carry out research and development activities. The students must have access to scientific Journals and other modern library facilities. There must be availability of qualified and experienced research oriented and motivated faculty. Adequate financial provision must be present to carry out research activities.

III. PERFORMANCE EVALUATION

It is quite clear that these individual factors will have different influence and importance. Thus, to evaluate the extent of influence of these factors on effectiveness, we consider an exponential model for effectiveness as follows.

$$\text{Effectiveness [Ef]} = K[A]^a [B]^b [C]^c [D]^d [E]^e [F]^f [G]^g \quad (1)$$

Where,

K= constant of proportionality

a, b, c, d, e, f and g are indices of factors

A, B, C, D, E, F and G are the factors

The factor indices here, shall demonstrate their influence on the respective factors A, B, C, D, E, F and G.

The equation (1) can be written in simple first order form by taking the logarithm of both sides of the equation.

Thus the equation (1) becomes

$$\log_{10} [\text{effectiveness}] = \log_{10} K + a \log_{10} A + b \log_{10} B + c \log_{10} C + d \log_{10} D + e \log_{10} E + f \log_{10} F + g \log_{10} G$$

The mathematical values of A, B, C, D, E, F, G represent the existing status of the factor in the institutions under study.

A. Evaluation Methodology

The data was collected from six Institutions (I₁, I₂, I₃, I₄, I₅, I₆) affiliated to same university imparting Technical education. A questionnaire was prepared for assessing the role of factors and their influence on effectiveness.

The questionnaire and weightage design was arrived at in consultation with the experts. This exercise led to following weightages -

$$W_A = 0.16, W_B = 0.14, W_C = 0.19, W_D = 0.14, W_E = 0.13, W_F = 0.13, W_G = 0.11, \text{ Such that } W_A + W_B + W_C + \dots = 1$$

Similarly, the evaluation scheme for each question was arrived at by averaging the opinion of all the experts and assigning 100 points to each factor.

B. Chi-Square Test:

As per the sample size the maximum permissible Chi-square value is found out from standard table and it is compared with estimated chi-square value. The estimated chi-square value should be less than the tabulated value, otherwise the assumption of exponential model is discarded

In our model the maximum permissible chi-square value is found out from the table, for 5 degrees of freedom (as 6 is the sample size, d.o.f. = 6 - 1 = 5) and 95 % probability, it is found out to be $\chi^2_{\text{Max}} = 11.07$

After putting in the data collected, the exponential model becomes

$$\text{Ef} = 0.0087 (A)^{2.13} (B)^{1.78} (D)^{2.57} (F)^{2.56} (G)^{2.27} \text{ with the estimated chi-square value as 15.61, which is greater than the standard chi-square value 11.07. Hence, the initial assumption of exponential model is discarded and instead, a linear model as under is proposed-}$$

$$\text{Ef} = K + C_1[A] + C_2[B] + C_3[C] + C_4[D] + C_5[E] + C_6[F] + C_7[G] \quad (2)$$

The chi-square value for this model is found out to be 0.13 which is negligible as compared to tabulated chi-square value (11.07). This indicates that the linear model shows a better fit of the data and hence this model is adopted.

C. Data Analysis

Data collected is tabulated below

Institutions	Ef	A	B	C	D	E	F	G
I ₁	47	77	82	81	80	81	80	89
I ₂	48.3	85	81	96	88	77	80	86
I ₃	45	85	85	87	84	87	81	82
I ₄	41	84	73	79	74	71	70	70
I ₅	41	63	75	70	80	62	72	59
I ₆	56	81	78	81	78	73	84	73
Weightages		0.16	0.14	0.19	0.14	0.13	0.13	0.11

The weighted values for the data set are given below.

Inst.	Ef	A	B	C	D	E	F	G
I ₁	47.00	12.32	11.48	15.39	11.20	10.53	10.40	09.79
I ₂	48.30	13.60	11.34	18.24	12.32	10.01	10.40	09.46
I ₃	45.00	13.60	11.90	16.53	11.76	11.31	10.53	09.02
I ₄	41.00	13.44	10.22	15.01	10.36	09.23	09.10	07.70
I ₅	41.00	10.08	10.48	13.30	11.20	08.06	09.36	06.49
I ₆	56.00	12.96	10.92	15.39	10.92	09.49	10.92	08.03

Table 2 shows Correlation Coefficient Matrix.

TABLE 2
Correlation Matrix

	Ef	A	B	C	D	E	F	G
Ef	1	0.35	0.33	0.37	0.17	0.26	0.86	0.36
A	0.35	1	0.39	0.79	0.18	0.69	0.40	0.63
B	0.33	0.39	1	0.63	0.71	0.88	0.75	0.79
C	0.37	0.78	0.63	1	0.72	0.67	0.54	0.77
D	0.16	0.18	0.71	0.72	1	0.43	0.48	0.53
E	0.26	0.68	0.88	0.67	0.44	1	0.62	0.86
F	0.86	0.40	0.75	0.55	0.49	0.62	1	0.62
G	0.36	0.64	0.79	0.78	0.53	0.86	0.62	1

D. Observations from the Matrix of Correlation Coefficients

1. Administration is having high correlation with Teaching Effectiveness (0.7898), Research & Development (0.6370) and Interaction with Industry & Society (0.6975). Hence administration can be merged with Teaching Effectiveness, R & D, and Interaction with Industry and Society.
2. Interaction with Industry & Society is also having high correlation with infrastructure (0.8866) and R&D (0.8625). Hence, Interaction with Industry & Society can be merged with infrastructure and R & D
3. The factor Student is having high correlation with Teaching Effectiveness (0.7180) and Infrastructure (0.7098). Hence it can be merged with these factors.

Thus, after merging the three factors as above, we are left with following four factors.

1. Infrastructure (B)
2. Teaching Effectiveness (C)
3. Extra Curricular Activities (F)
4. Research & Development (G)

and the proposed model is simplified as under-

$$E_f = K + C_2(B) + C_3(C) + C_6(F) + C_7(G)$$

E. Determination of Percent Variations in Effectiveness

From the analysis of data on SPSS software following lines of regressions and their percentage fits are obtained.

1. Line of Regression of Extra Curricular Activities on Effectiveness.

The line of regression obtained is

$$E_f = -21.85 + 6.74(F)$$

The percentage fit of above line is obtained by

$$\% \text{ fit of line} = R^2 \times 100$$

$$\% \text{ fit of line} = 0.75097 \times 100$$

$$= 75.097 \%$$

2. Line of Regression of infrastructure and Extra Curricular Activity on Effectiveness

The line of regression obtained is

$$E_f = 6.37 - 6.57(B) + 11.13(F)$$

$$\% \text{ fit of line} = 0.99075 \times 100$$

$$= 99.075 \%$$

3. Line of Regression of Infrastructure, Extra Curricular Activities and Research and Development on effectiveness.

The line of regression obtained is

$$E_r = 12.51 - 7.58(B) + 11.06(F) + 0.69(G)$$

$$\% \text{ fit of Line} = 0.99928 \times 100$$

$$= 99.928 \%$$

4. Line of Regression Infrastructure, Extra curricular Activities, Teaching Effectiveness and R & D on Effectiveness.

The line of regression obtained is

$$E_f = 11.59 - 7.56(B) + 0.15(C) + 11.02(F) + 0.54(G)$$

$$\% \text{ fit of line} = 1.0000 \times 100$$

$$= 100.00 \%$$

The best fit line is selected for our effectiveness model which becomes

$$E_f = 11.59 - 7.56(B) + 0.15(C) + 11.02(F) + 0.54(G)$$

This model can be used to measure the effectiveness for the set of Institutions that participated in data collection.

IV. CONCLUSION

In this paper, we have briefly examined the various factors which affect the effectiveness of technical education and have categorized them into seven major heads. A mathematical model has been evolved for assessing the effectiveness in terms of these factors. The proposed model can be used to quantify the effectiveness of a technical institution with very good accuracy.

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Annexure-1

TABLE-1
Input Factors Affecting Effectiveness

K. B. Powar & S. K. Panda,1995	Has identified input factors responsible for TQM are course validation, course review, audit, inspection, moderation, performance indicators and accreditation
Sangeeta Sahney et al.,2004, 2007	Identify the different customer and their requirement. Expectation and requirement of a customer. Student perspective and administrative staff perspective. physical facilities and infrastructure
Ahuja I.P.S. and Singh T. P., 2004	Curriculum development in emerging technologies, Faculty development, Modernization and better utilization of infrastructural facilities, Enhanced exposure of students to industries, Feed back system, Autonomy to technical institutions. Fostering / Promotion of Research Aptitude in Graduates, Networking between Institutions, Institution-Industry Interaction, Accreditation of Institutions, Resource Mobilization and Continuing Education Programs
Roma Mitra et al., 2007	Infrastructure, Faculty, curriculum, stakeholder and System and policies.
Shun-Hsing Chen, 2006	mission and vision, financial measurement and customer prospective
P.B.Sakthivel,2005,2006, 2007	Commitment of top management and leadership. customer focus, course delivery, communication, campus facilities, congenial assessment and improvement
Surendra V. Gole, Dhanjay Jolhe, 2007	Knowledge, Skill, Performance and Behavior.
Sushma kulkarni, 2005	Customers, governments, other industries, funding agencies and public.
Mallesham P, 2005	The quality of technical education system depends on the institution, vision, mission long range goals, short range goals, infrastructure, faculty's research and development activities and industry-institutions interaction , curriculum, examination and evolution system, students, placement and consultancy etc.