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Teachers' Outlook on Improvement of Quality of Engineering Education in India

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Abstract: - Engineers are the initiators, facilitators, and implementers of the technological development of a nation. If we understand the relative strengths and weaknesses of the engineering programmes with respect to different factors as perceived by the stakeholders who are constantly in touch with the programme, the concerned organizations can create some action plans for improving the state of engineering education. This paper presents a study to prioritize the factors for the quality improvement of undergraduate engineering education in India. The studies include multi-criteria, multilevel decision-making based on the subjective opinions of the respondents. Analytic Hierarchy Process (AHP), which is a powerful tool for such a situation, has been utilized for the study. 'Faculty Adequacy', 'Student Performance', 'R&D activities', 'Financial Resources' and 'Performance Appraisal & Development mechanism' came out as the most critical factors, which need immediate attention for the improvement of quality of engineering education in India.

Keywords: - Quality assessment, AHP, Engineering in India, Quality indicators, Quality Barriers

1 Introduction

In the wake of a quantum jump in technologies with global connectivity, coupled with the new liberalized socio-economic revival, a need to undertake an intensive systems analysis and a consequent restructuring in all aspects that control, regulate and spread engineering education in India is gaining attention of the educators and other stakeholders [1]. Moreover, the technical nature of engineering education makes it unique in content and approach and thereby requiring special care and attention, which constitute the motivation for this study.

In order to reduce the burden on the government in educational provision, in many countries, public administrators consider economic factors the most important ones, and most of the time it is the economic considerations that drive individuals and shape social and public policy [2]. The new economic policy regards expenditure on higher education as less of an investment of the nation in the future and more of a subsidy to a relatively affluent section of society. This has created a need for private resources and a new species of 'businessmen as providers of technical education' has emerged [3].

The way engineering education is conducted is important to the future of the engineering profession in the context of the growing gap between the need for well-trained engineers and the ability of colleges to produce such engineers. If we understand the relative strengths and weaknesses of the engineering programmes with respect to different factors, as perceived by the stakeholders, who are constantly in touch with the programme, the concerned organizations can create some action plans for improving the state of engineering education. This paper presents a study to identify the ways and means to improve the quality of undergraduate engineering education in India. The paper is organized as follows. A discussion on views on quality of engineering education and its measurement is presented in the second section. Framework of the study is explained in the third section through the steps of Analytic Hierarchy Process. Fourth section deals with the results and discussions and the paper ends with concluding remarks.

2 Views on quality and its measurement

Education quality is a multi-dimensional concept [4]. It can be viewed as the combination of the quality of input, process, and output of the education system. Many opinions can be observed in the literature about the factors influencing the quality in engineering education. Some of them are teaching process [5], University – Industry collaboration [6], role of management [7], student intelligence & interest [8], excellence of teachers [9], accreditation standards [10], e-education [11] and proper documentation of activities [12]. For some of the academicians, quality is synonymous with the continuous improvement [13].

They advocate for implementation of TQM in educational institutions [14, 15, 16, 17, 18] for quality improvement. It is clear from the above literature review that the quality of engineering education cannot be defined by any single factor or dimension. The authors have viewed quality as the combination of various factors. In order to create a smoother transition from education to practice, some argue that engineering education should put more emphasis on the engineering-based knowledge [19].Definition of indicators of quality and the objective measurement of these indicators are critical in the assessment of quality of engineering programmes [20]. Rao [21] presents a logical approach to rank the technical institutions in India using graph theory and matrix approach. Suganthi et al, [22] propose a 'Failure Mode and Effect Analysis', which have been used extensively in industries as a proactive tool for education sector. Some authors [23, 24] have illustrated the use of AHP for performance evaluation of technical institutions.

All these proposals are at conceptual level with out any proven applicability. Hence, a framework has to be developed to analyze the quality as well as to prioritize those factors, which lead to the improvement of quality of engineering education. As the official performance assessment mechanism of Indian engineering education system is the National Board of Accreditation (NBA), India, studies have formulated based on NBA processes and criteria. Initial studies revealed the dominance of a single component in the NBA process [25] and points out that with the determination of a single criterion score, the prediction of accreditation chance of a programme can be done with sufficient accuracy [26]. A third study to find out the underlying factors behind the NBA processes resulted in the identification of 19 performance assessment factors [27]. These factors are also categorized with respect to the criticality of assessing the performance of an engineering programme [28]. The NBA criteria and the names & criticality of factors derived through these studies are depicted in Table 1. These factors form the basic framework of the study.

3 Framework of the study

Performance assessment has to be analyzed systematically [29]. The interest here is to find out the impediments currently existing in the undergraduate engineering education sector and to prioritize the initiatives needed for the improvement of quality of education provided by the engineering programmes. The 19 factors derived from the previous study are selected for identifying the barriers to the quality improvement of engineering education in India. The study involves the collection of subjective opinions & information of experts and multilevel decision-making. Hence, the study is planned as an Analytic Hierarchy Process. The entire framework of the study is displayed in Figure 1.

Table 1: Derived factors and their criticality

NBA Criteria	Derived Factors	Criticality of Factors
I . Organization and Governance	1. Participatory Management	Vital
	2. Leadership Efficiency	Desirable
	3. Commitment to achieve goals	Essential
	4. Planning and Monitoring	Essential
II. Financial & Physical Resources and their Utilization	5. Financial Resources	Essential
	6. Supplementary Physical Resources	Desirable
	7. Main Physical Resources	Essential
III. Human Resources: Faculty& Staff	8. Performance Appraisal & Development	Essential
	9. Supporting Staff Adequacy	Desirable
	10. Faculty Adequacy	Vital
IV. Human Resources Students	11. Student Performance	Vital
	12. Student Intake	Desirable
V. Teaching – Learning Processes	13. Learning Facilities	Vital
	14. Instruction, Evaluation and feedback	Vital
	15. Academic calendar	Vital
VI. Supplementary Processes	16. Supplementary Processes	Desirable
VII. Industry – Institution Interaction	17. Institute initiatives	Essential
	18. Industry Initiatives	Desirable
VIII. Research & Development	19. R&D Activities	Essential

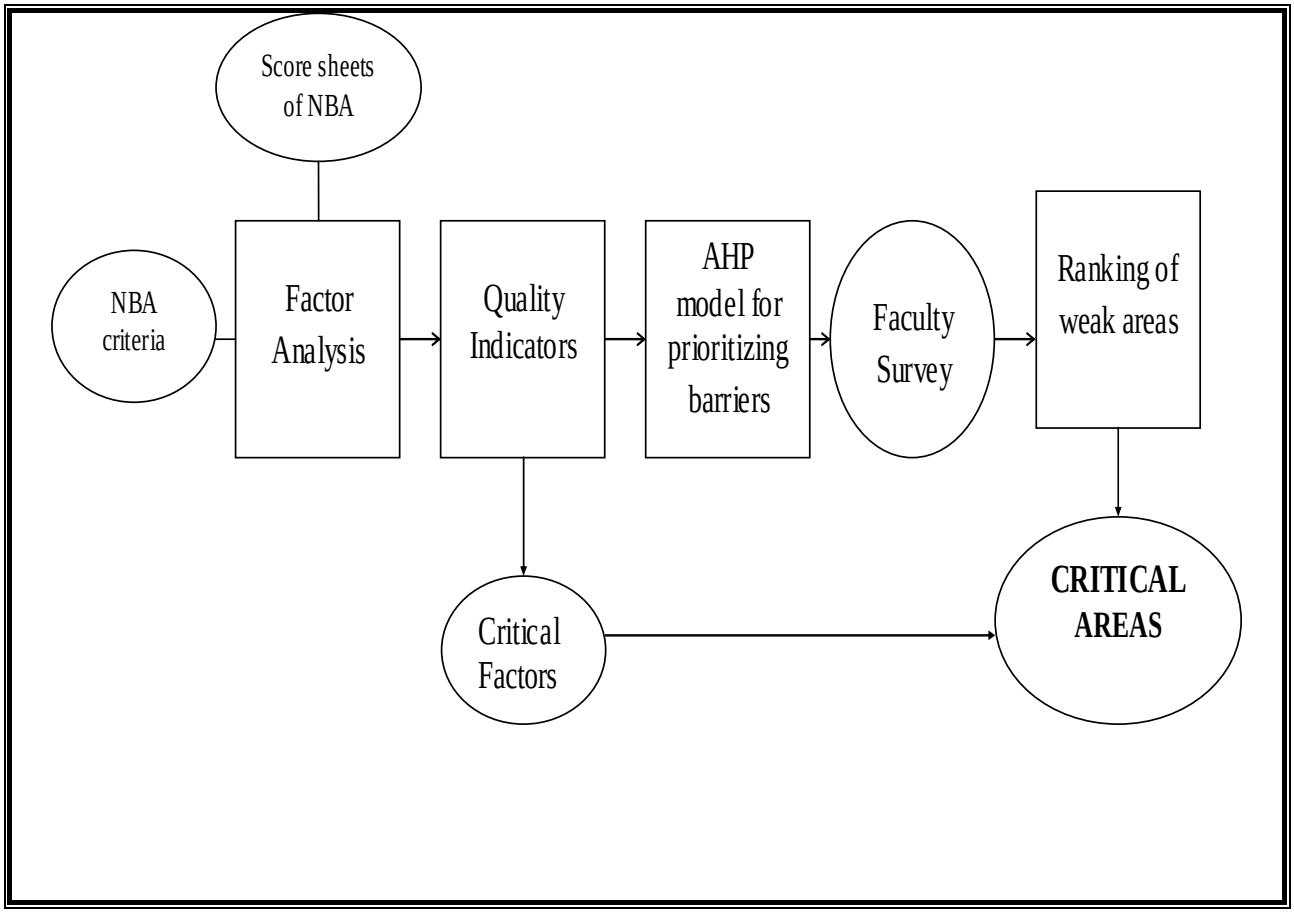

Fig. 1: Framework of the study

3.1 Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) is a mathematical technique used for multi-criteria decision-making. It enables us to incorporate tangible as well as non-tangible factors especially where the subjective judgments of different individuals constitute an important part of decision-making [30]. AHP uses a five-step process to solve decision problems. They are

1. Create a decision hierarchy by breaking down the problem into a hierarchy of decision elements. The topmost level of hierarchy specifies 'focus' of the study. Intermediate levels correspond to criteria and sub criteria, while the lowest level contains the 'decision alternatives'.
2. Collect inputs by a pair-wise comparison of decision elements
3. Determine whether the input data satisfy a consistency test. If not, go back to Step 2 and redo the pair wise comparisons:
4. Calculate the relative weights of the decision elements
5. Aggregate the relative weights to obtain scores and hence rankings for the decision alternatives:

3.2 Decision hierarchy

As the number of factors to be prioritized is 19, which is a bigger number for one-shot pair-wise comparison, a two level study has been planned. The 19 factors are categorized into 6 groups of Organization & Governance, Financial & Physical Resources, HR – Faculty & Staff, HR – Students, Teaching Learning Process and Other Processes (Combination of Supplementary Processes, Industry – Institution Interaction and Research & Development criteria). These groups are compared at the first level and the factors within these groups are compared at the second level. Initially, responses are collected to prioritize the groups based on their weaknesses (urgency of initiative for improvement) in a particular programme. At the second level, the factors were prioritized based on their importance in improving the corresponding group.

3.3 Collection of expert opinions

The present study consists of the prioritization of the 19 derived factors with respect to their weaknesses in various categories of engineering programmes in

India. There are many stakeholders of engineering education, namely, students, teachers, parents, industries that employ the graduates and management of colleges. While perceptions of all the stakeholders are important, all of them other than the teachers have limited interactions with the system and can assess only some of the quality characteristics of the programme. The teachers have a role to play with regard to all the 19 factors. Hence, the teachers of undergraduate engineering programmes are selected as the respondents for the survey. Respondents were randomly selected from faculty members undergoing Quality Improvement Programme (Q.I.P) – either studying for PG or PhD or attending refresher courses. These teachers have been with the programmes long enough to qualify for QIP and can be expected to be with the teaching profession for considerable time after their QIP. They have the knowledge and experience to prioritize the factors with regard to the quality improvement of the engineering programmes. It can be assumed that this sample selection provided openness, randomness as well as quality awareness in the responses. One hundred and sixty faculty members representing one hundred and sixty programmes from various parts of India were personally interviewed for data collection.

The teachers were requested to rank the factor groups with respect to their importance in improving the performance of the respective engineering programme. Then, they were asked to compare the relative importance's of these factor groups with each other and to mark them on the given 1-9 scale. The same procedure is repeated for the factors coming under each factor group by comparing their relative importance in improving the factor group of the programme. Respondents were requested to note two points while filling up the questionnaire.

- All responses should be in the light of the situation prevailing in their department in their institute.
- Factors, which need immediate attention and improvement in their department should be given higher score.

3.4 Priorities and consistency of comparisons

The ranking of alternatives and the individual attention of the researcher to each of the responses assured consistency of responses. The responses are entered in the positive reciprocal matrix and the geometric means of these responses are calculated to get the overall group response. The group response is entered to get the judgmental matrix. Local priorities of the alternatives are calculated and the consistency of the judgments is also determined from the judgmental matrix. The mean group responses are found to be consistent. Importance of various factors in improving quality of engineering education is calculated from the principle of hierarchic composition [31]. Weights of Groups & factors and ranking of the factors in terms of their urgency of attention to improve the quality of education given in Table 2.

Table 2: Importance of factors for improving the quality of education

	Weights Factors	Weights Factor groups	Weights (Final)	Ranks
1.Participatory Management	0.24	0.154	0.037	17
2.Leadership Efficiency	0.205	0.154	0.032	18
3.Commitment to achieve goals	0.266	0.154	0.042	16
4.Planning and Monitoring	0.289	0.154	0.044	15
5.Financial Resources	0.366	0.172	0.063	5
6. Main Physical Resources	0.286	0.172	0.049	10
7. Supplementary Resources	0.348	0.172	0.0599	7
8. Faculty Adequacy	0.344	0.178	0.061	6
9. Supporting Staff Adequacy	0.287	0.178	0.051	9
10. Performance Appraisal & Development	0.369	0.178	0.0656	4
11. Student Quality	0.468	0.145	0.068	3
12. Student Performance	0.532	0.145	0.077	2
13.Learning Facilities	0.34	0.137	0.0469	12
14.Instruction, Evaluation and Feedback	0.333	0.137	0.0451	13
15.Academic Calendar	0.327	0.137	0.0449	14
16.Supplementary Processes	0.12	0.214	0.026	19
17.Institute Initiatives	0.222	0.214	0.0471	11
18.Industry Initiatives	0.278	0.214	0.0595	8
19.R&D Activities	0.38	0.214	0.081	1

4 Results and Discussions

The analysis of opinions of faculty members from 160 engineering programmes from various parts of India reveals that the weakest group factor that requires immediate attention for improvement of

quality of engineering education is the supporting processes (Other processes). Human resources – Faculty & Staff and Financial & Physical Resources are the other two groups, which ask for immediate improvement. R&D activities, Student Performance, Student Quality, Performance Appraisal & Development and Financial Resources are rated as the first five weak areas of the Indian engineering education sector (Table 2). After considering the criticality of the factors (Table 1) and the relative weaknesses of each of them in the Indian scenario (Table 2), the important factors can be classified into four groups namely Vital-Strong, Vital -Weak, Essential-Strong and Essential-Weak.

Vital-Weak: Faculty Adequacy and Student Performance

Essential-Weak: R&D activities, Financial Resources and Performance Appraisal & Development

Essential-Strong: Institute Initiatives, Commitment to achieve goals, Planning and Monitoring and Main Physical Resources

Vital -Strong: Instruction, Evaluation and Feedback, Academic Calendar, Learning Facilities and Participatory Management

Strong factors are the safe factors that are in good condition and do not need any immediate attention. Initiatives to overcome the weaknesses in the weak factors are essential in improving the quality of undergraduate education in India. Faculty Adequacy, Student Performance, R&D activities, Financial Resources and Performance Appraisal & Development mechanism came out as the most critical factors, which need immediate attention for the improvement of quality of engineering education in India.

5 Conclusions

This paper discloses the outlook of faculty members through a structured approach. As the faculty members are one the prime stakeholders of engineering education, their observations have immense value in improving the quality of engineering education. A good insight about the overall quality issues of engineering education in India is obtained from the present study. A comparison of issues in various categories (Autonomous, Aided and Self-financing) of colleges is proposed for a future study.

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