Decision Analysis Approach for Quality in Technical Education

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Abstract- **The Analytical Hierarchy Process (AHP) provides a methodology for multi-criteria analysis and decision making. It allows critical examination of the underlying assumptions, consistency of the judgments, and facilitates the incorporation of qualitative and subjective considerations into quantitative factors for decision making. Here an Analytic Hierarchy Process (AHP) approach is used for the analysis and comparison of the quality of several technical institutes The AHP method uses paired comparison to weight the importance degrees that affect the quality of education/service in a hierarchical structure. A particular formulation is presented and discussed extensively. The present study makes an attempt to enlist various factors that affect Technical Education and further develops a mathematical model to measure its effectiveness.**

Keywords- Decision analysis; Multi-criteria decision making; Analytical Hierarchy Process; Technical education;

I. INTRODUCTION

We live in the information age where technical education plays an important part in our career. The Technical education field today is a much more competitive market and students/customers have a variety of services, courses and institutes/universities to choose from. Students/Customers of technical education demand a high quality education and services (like job placement etc.) from their institutes/universities. They have the opportunity to determine quality of educational services that they need, balancing their cost and course/value. It is therefore essential that institutes/universities provide the best quality of educational service available. In this paper, we focus on a specific problem namely; the dilemma faced by a student/customer in choosing a technical institute/university that best satisfies his needs. We illustrate how a student can utilize the Analytic Hierarchy Process to scientifically choose an institute/university that best satisfies his needs for quality education and service. As an example, three institutes/universities are being compared in terms of the quality of services offered. Certain factors which have a significant impact on the quality of educational services have been considered in this study. The relative importance of each of these factors and their effect on the quality of education are determined by performing pair wise comparisons between them. This enables us to prioritize

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them in order of importance. The next step is to determine the importance that each institute/university assigns to these factors in its quality improvement program. The decision making process in this case is greatly 'simplified by solving the problem in a numerical manner. It is, therefore, attempted here: 1. Identify various factors affecting the effectiveness of technical institution 2. 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.

Criteria affecting the quality of technical education

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 quality enhancement in technical education are summarized here.

The literature [1] clearly indicates that there are various factors which directly or indirectly influence the effectiveness (Quality) in technical education. Here we group these factors under six broad heads as discussed below

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

A. *Administration*

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*

"We shape our institution and our institution shapes us", Winston Churchill. An institution must have adequate land,

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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*

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 conductive atmosphere for the teacher.

D. *Students*

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 is 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*

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 curriculum, with industry oriented programs and to establish a close link between an educational program and social needs.

F. *Research and Development*

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.

II. The Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) is a technique used for dealing with problems which involve the consideration of multiple criteria simultaneously. It is unique in its ability to deal with intangible attributes and to monitor the consistency with which a decision maker makes his decisions. Some of its applications include Transport Planning in the Sudan [2], choosing a Modern Computer System [3] and Political Candidacy [4]. The steps to be followed while implementing the AHP process are illustrated below [5].

Step 1 - Set up a decision hierarchy by breaking down the problem into a hierarchy of interrelated decision elements. The overall goal is placed at the top, with the main attributes on a level below.

Step 2 - Collect input data by pair-wise comparisons of decision elements. Every attribute on each level is compared with adjacent attributes in respect of their importance to the parent.

Step 3 - Use the "eigen value" method to estimate the relative weights of decision elements. The options available to the decision maker are now scored with respect to the lowest level attributes. Step 4 - Aggregate the relative weights of decision elements to arrive at a set of ratings for the decision alternatives. The scores reflecting the weight given to each attribute are adjusted and then summed to yield a final score for each option.

The decision schema of the analytic hierarchy process is shown below in figure 1.

A distinction is made between local and global priorities. A local priority reflects the importance (priority) of an element in a certain level with respect to an element immediately above it. A global priority reflects the importance of an element with respect to the focus of the problem. The derivation of local priorities is carried out through the use of a comparison scale and a pair wise comparison matrix [6]. A comparison matrix for deriving the priority vector $w = [w_1, w_2, w_3]$, is associated with 3 elements in a specific level with respect to a single element in a level immediately above it. Such a matrix is de-noted by A.

$$A = \begin{bmatrix} w_1/w_1 & w_1/w_2 & w_1/w_3 \\ w_2/w_1 & w_2/w_2 & w_2/w_3 \\ w_3/w_1 & w_3/w_2 & w_3/w_3 \end{bmatrix}$$

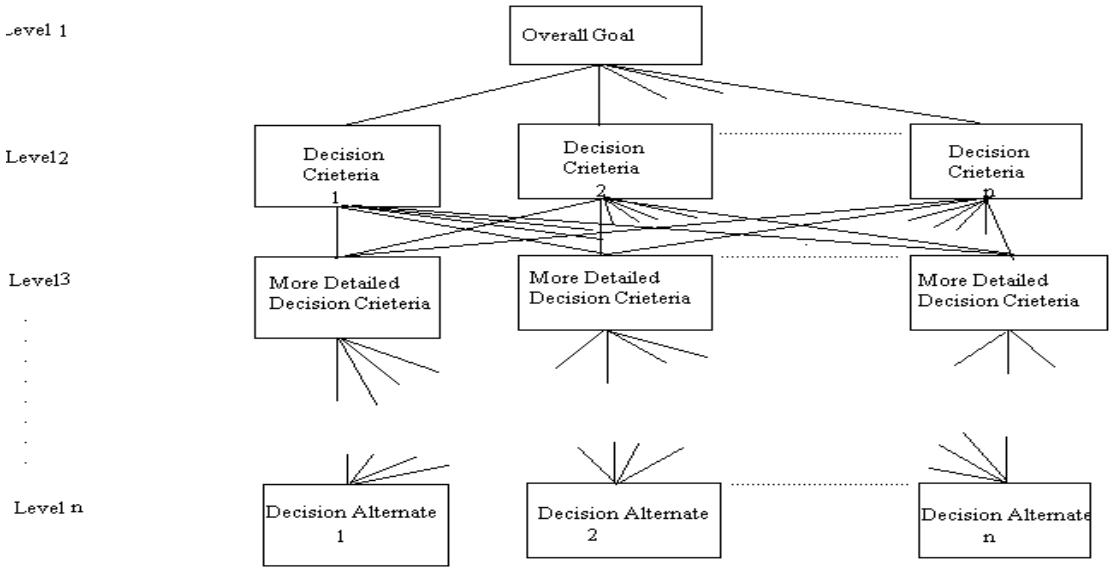


Figure 1

In this matrix, every element a_{ij} is the result of a pair wise comparison denoting the dominance of element i relative to element j. A comparison is also being made of the jth element with the ith element. This results in the comparison matrix being a reciprocal matrix satisfying $a_{ij} = 1 / a_{ji}$. The pair wise comparison is performed using the 1-9 scale suggested by Saaty [1]. It is observed that for the matrix given above the following relation holds: Aw = nw, where w is the priority vectorand n is the number of elements being compared. This is the case for a perfectly consistent comparison matrix whose elements satisfy $a_{ik} = a_{ij} * a_{jk}$ for all (i , j , k). In this consistent case the matrix A is written as:

$$A = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \end{bmatrix} \quad [1/w_1 \quad 1/w_2 \quad 1/w_3]$$

In this special case every column of this perfectly consistent matrix provides the solution to the eigen vector problem associated with the largest eigen value. In general we have $w = \lambda_{max} w$, where λ_{max} is the largest or principal eigen value of the comparison matrix, which can be shown to satisfy $\lambda_{max} \geq n$, (n is the order of the matrix) with equality holding true only in the perfectly consistent case. The consistency index (CI) is an indication of the accuracy of the method and is defined as:

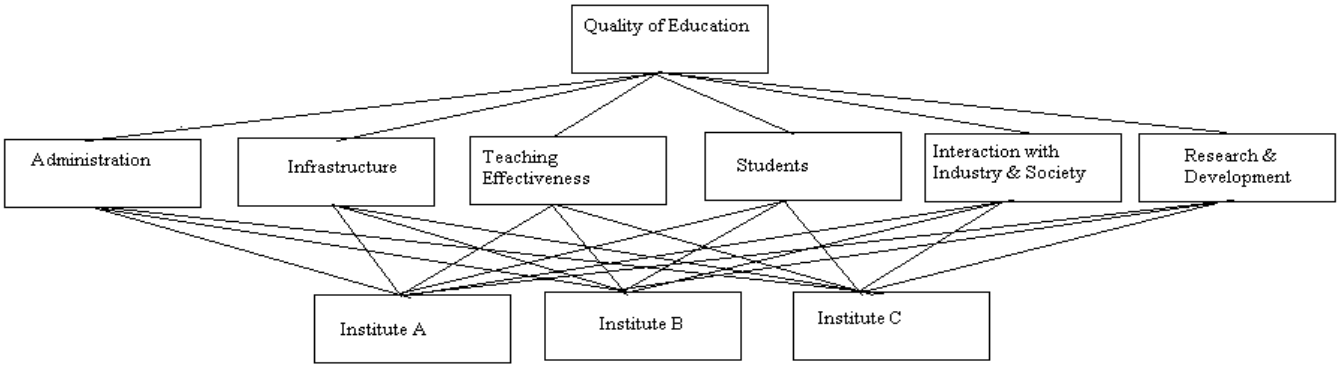
$$CI = (\lambda_{max} - n)/(n-1)$$

This consistency index will assume the value zero only in the perfectly consistent case and will be positive otherwise. Several properties of the AHP method are presented in [7]

III. Application of the AHP Method

The decision scheme required for our specific problem is illustrated below in figure2. The overall goal and the factors which affect this goal are defined. The relative weights assigned to these factors by each of the institute under consideration have to be determined.

Figure2 – The Decision Scheme



It is first necessary to prepare a global matrix comprising the factors affecting quality. Pair wise comparisons between elements of this matrix yield certain numerical values.

A. *Global Matrix*

A glance at this global matrix tells us how important a certain factor is in comparison to the other factors (Figure 3). For this global matrix, the principal eigen value $\lambda_{max,}$ the consistency index (Cl) and the consistency ratio are calculated. The random index (RI) for n =6 order matrix is 1.24. These values indicate the consistency of the method used. The priorities assigned to elements of the matrix reflect the order of their importance in the decision making process.

	Administratio	Infrastructure	Teach. Effec.	Students	Inter. with Ind.& Society	R& D
Administration	1					
Infrastructure		1				
Teach. Effec.			1			
Students				1		
Inter. with Ind.& Society					1	
R& D						1

Figure 3 – Global Matrix

IV. Comparison Between Three Institutes

The next step is to compare the importance that each institute assigns to these factors. Six matrices are constructed (Figure 4) and pair wise comparisons are performed between the elements.

Administration

	A	B	C
A	1		
B		1	
C			1

Students

	A	B	C
A	1		
B		1	
C			1

Infrastructure

	A	B	C
A	1		
B		1	
C			1

Interaction with Industry & Society

	A	B	C
A	1		
B		1	
C			1

Teaching Effectiveness

	A	B	C
A	1		
B		1	
C			1

Research & Development

	A	B	C
A	1		
B		1	
C			1

Figure 4 - Comparison Matrices

The objective is to determine the relative priority that each institute assigns to a given factor.

The overall weight of an institute indicates the emphasis that the institute gives to these factors and is arrived at in the following manner.

We tabulate the priorities obtained by these pair wise comparisons. This matrix is multiplied with the matrix of the relative priorities of the six factors as obtained earlier.

$$\begin{bmatrix} a_A a_I & a_T a_S & a_{IS} a_R \\ b_A b_I & b_T b_S & b_{IS} b_R \\ c_A c_I & c_T c_S & c_{IS} c_R \end{bmatrix} \begin{bmatrix} A \\ I \\ T \\ S \\ IS \\ R \end{bmatrix}$$

The two matrices are multiplied to obtain the overall weight of each company as shown below.

Overall weight of Institute A =

$$a_A A + a_I I + a_T T + a_S S + a_{IS} IS + a_R R$$

Overall weight of Institute B=

$$b_A A + b_I I + b_T T + b_S S + b_{IS} IS + b_R R$$

Overall weight of Institute C=

$$c_A A + c_I I + c_T T + c_S S + c_{IS} IS + c_R R$$

The order of priority assigned to the different factors by an institute is compared with the priority assigned to the factors by a competent student. Based on a careful observation of the tabulations, the competent student can arrive at a decision to choose a particular institute/university. The institute/university with the largest overall weight is usually chosen, provided however that the institute/university offers its courses at a reasonable cost. If the cost of course offered by this institute/university is not reasonable then the student must arrive at a trade off between the overall weight and the cost of course provided.

V. Conclusion

The research effort of this paper is to integrate AHP and Quality factors into the Institutes driven course design process. In this paper, we have briefly examined the various factors which affect the effectiveness of technical education and have categorized them into six 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. Student's views on these criteria are determined by having them fill out suitably prepared questionnaires. Students could use this framework to specify the technical education quality attributes they require. They could compare course and service offerings available from various institutes to quantitatively determine the impact on their career of available infrastructure and quality alternatives. A search strategy is also

employed to establish target values of institute .characteristics for the recommended course alternative

VI. References

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