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By

Debmallya Chatterjee,
Assistant Professor,
T. A. PAI Management Institute (TAPMI),
Manipal 576104, Karnataka, INDIA
Email: debmallya@tapmi.edu.in

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T. A. PAI Management Institute
Manipal – 576104, Karnataka

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Debmallya Chatterjee
Assistant Professor,
T.A. Pai Management Institute, Manipal, Karnataka
Email: debmallyac@tapmi.edu.in

Abstract: The importance of technical institutions is increasing day by day as the country progresses. It helps not only in imparting engineering education but also through developmental-activities in nation building. Before the era of privatization in India, a technical institution was mainly governed by the government of the state or country. But today lots of technical institutions have emerged with a majority of them compromising with the quality. Many agencies are publishing articles on the institutional ranking where most of them are done based on perceptions. The stakeholders are confused in understanding how the quality of education is provided by the different institutions and thus the selection of an institution often goes wrong. This selection is a multiple factor decision making process and hence this paper proposes the use of Analytical Hierarchy Process (AHP) in the evaluation of technical institutions and the results are illustrated using a case study of three technical institutions.

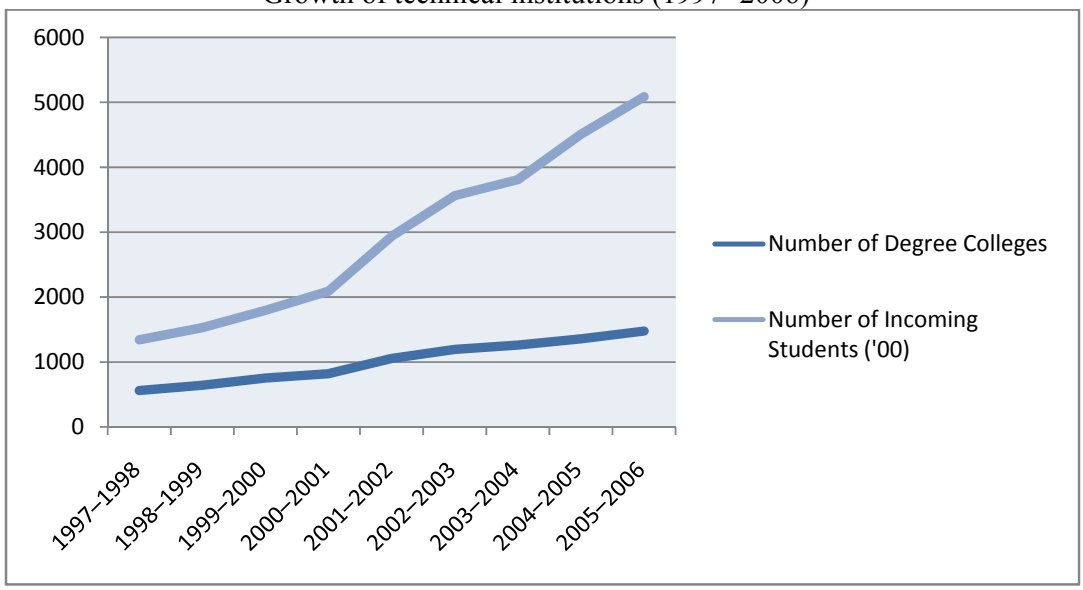
Key words: Multi-factor decision making, AHP, technical education
AMS Classification 2010: 90B Operations research and management science

1 Introduction

1.1 Aim of the present Study

Technical education in India plays a vital role in the social and economic development of our nation. It not only includes engineering education but also contributes in the developmental activities of the nation. In India, technical education is imparted at various levels such as: craftsmanship, diploma, under-graduate & post-graduate level engineering degree and research in industrial/applicable specialized fields, catering to various aspects of technological development and economic progress. Since the era of liberalization, globalization and privatisation there is a metamorphic turn around in the field of technical education in India. The growth is significant and can be seen from the Figure 1.

Figure 1
Growth of technical institutions (1997- 2006)



Source: Annual Report 2005–06, Dept. Secondary and Higher Education, Min. of HRD, Govt. of India.

Out of thousands of private self financing technical institutions that have emerged, a few are offering quality education but many of them are compromising with the quality. Low quality engineering schooling has come to pre-dominate the education market (Varshney, 2006). The stakeholders are confused in selecting a quality institution for their career development and prosperity. Because of these low quality institutions the graduated student has become a suspect (Sengupta, 2006). This phenomenon raises the important question: how to select a quality institution?

The selection or evaluation of an institution is based on multiple factors or dimensions and is important to various stakeholders (Sadlak, 2010). It has been observed over the years that a number of agencies publish institutional rankings intending to provide some light on the quality of an institution, but most of them are done globally or across pan India with institutions having different mission, vision, geographical and cultural difference. The reliability of such media rankings are criticized by academic groups (Stella and Woodhouse, 2006). Critics also assert that the institutions manipulate data in order to achieve higher rank (Dill and Soo, 2004). Bengoetxea et al (2012) in their work on the higher education ranking stated that the fundamental weakness of the existing rankings is the unfair comparison of institutions varying in size and funding. Adding to the observation of Bengoetxea, Sadlak (2010) in

his article on ranking in higher education highlighted the importance of taking the institutional diversity into account while doing ranking. It has also been argued that classification of institutions is a prerequisite of sensible ranking combined with multidimensional ranking (Van der Wende et al, 2009).

Despite the criticism, the rankings are so far the only tool that provides a comparison of the efficacies of the institutions both nationally and internationally (Bengoetxea et al, 2012). In order to set a guideline on how to rank institutions globally using a robust and widely accepted methodology, the International Ranking Expert Group (IREG) founded jointly by the European Centre for Higher Education (UNESCO-CEPES) and the Institute for Higher Education Policy met in 2006 and developed a set of guideline known as 'Berlin principle'. According to these guidelines, an agency should provide necessary importance to the diversity in terms of mission, goal, geography and culture while ranking an institution (IREG, 2006). It is quite confusing when these agencies rank research oriented institutions with an institution having a different objective altogether. Thus according to Berlin principle it is necessary either to consider institutions with similar goal, geography and culture for applying ranking model or provide adequate measure in handling the diversity (IREG, 2006). Examination of some of the Indian ranking methodologies available in different websites (http://www.outlookindia.com, http://www.collegekhabar.com, http://www.indiatoday.in, http://www.career360.com) found that none of the methodologies had taken care of the issues raised in the guidelines of the so called 'Berlin principle'.

Apart from the above mentioned anomaly, these rating methods may also suffer when they try to capture the qualitative judgments in absence of quantitative values. In such a situation the decision maker can still move ahead recognizing whether one factor is more important than another by doing pairwise comparisons. Saaty (1980) established a consistent way of converting such pairwise comparisons (X is more important than Y) into a set of numbers representing the relative priority of each of the factor. The method is widely known as the analytical hierarchy process (AHP).There are numerous applications of AHP in decision making across different fields of study including operations and supply chain (Atthirawong et al 2002; Grewal et al 2008;

Jesuk 2005; Ozden et al 2005), human resource management (Grandzol 2005; Korkmaz et al 2008), engineering applications (Triantaphyllou et al 1995; Yang et al 2002), environment (Pavlikakis 2003), government (Altay 2008) and education (Das et al 2012; Viswanadhan 2005; Wu et al 2012). Almost all the researchers provided evidences of the applicability of AHP as a multi-factor decision making tool where the decision involves qualitative as well as quantitative evaluation. Wu et al (2012) used MCDM involving AHP in ranking universities based on performance in Taiwan and demonstrated how AHP can effectively be used in ranking educational institutes. Looking at the applicability of AHP and the multi factor problem nature of ranking technical institutions, this paper makes an attempt to apply AHP in evaluating technical institutions having equivalent mission, goal, culture and geographical location. The objective is also to see how well AHP can capture the qualitative differences prevailing among the technical institutions across different dimensions. For convenience in computation this is illustrated using a case of three institutions.

1.2 The Analytic Hierarchy Process

In multi-factor decision making situations, often the decision maker may have difficulties in accurately determining the various qualitative and quantitative factors and their importance in the decision. Often the problem occurs because of the qualitative nature of human responses (Saaty et al, 2008). In such cases where difficulties arise in generating importance of the factors using the qualitative responses, the Analytic Hierarchy Process (AHP) is one of the widely accepted tools that can be used (Shim, 1989). Because of its intuitive appeal and flexibility, many corporations and governments routinely use AHP for making major policy decisions (Elkarmi and Mustafa, 1993).

In AHP the decision maker starts by laying out the overall hierarchy of the decision problem. This hierarchy reveals the various factors to be considered as well as the various alternatives in the decision. There may be multiple levels within the hierarchy based on the sub factors available. For example, in a car purchase decision, the goal happens to be the purchase, the factors may be reliability, safety, look and mileage whereas the alternatives may be the set of cars the decision maker wants to

choose from. If the decision maker wants to go into more detail, he can consider various sub factors under different factors already taken. Here both qualitative and quantitative factors can be compared using a number of pair wise comparisons, which result in the determination of factor weights. Factor weights are numerical values quantifying the importance of the factor in the decision. The alternatives are then compared with respect to the factors or sub factors in the hierarchy and the scores are aggregated. The alternative with the highest total weighted score is selected as the best alternative (Saaty, 1980).

2. Methodology

2.1 Building the hierarchical structure of the problem

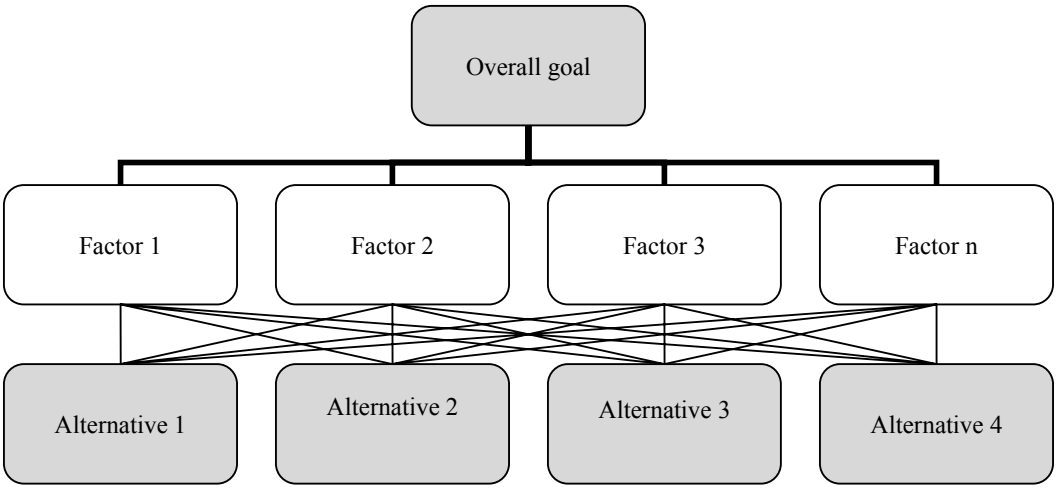
The hierarchy AHP is structured by Saaty from the top (the overall objective of the problem) through the intermediate levels (factor and sub-factor on which subsequent levels depend) to the bottom level (the list of alternatives/choice). Each factor is compared with respect to the other factors available in the same level of hierarchy using a scale described in Table 1.

Table 1
Pair wise comparison scale

Verbal judgment	Explanation	Number
Extremely Un-important (EXUI)	A criterion is strongly inferior to another	1/5
Un-important (UI)	A criterion is slightly inferior to another	1/3
Equally Important (EI)	Two factor contribute equally	1
Moderately Important (MI)	Judgment slightly favor one criterion over another	3
Extremely Important (EXI)	Judgment strongly favor one criterion over another	5

Finally the alternatives are compared among each other with respect to each of the factors or sub factors and the total score for an alternative is thus generated. Figure 2 describes the hierarchy of a decision making problem.

Figure 2
Decision hierarchy



2.2 Respondent selection

The analytical hierarchy process is a subjective decision making method and hence requires consistent inputs for its efficacy. Inconsistent inputs can lead to rejection of the entire set of data during consistency test of the input matrix. This character of AHP invites 'expert opinion' for consistent evaluations of the factor weight. In this piece of work the experts were selected from academia having more than fifteen years experience in the field of engineering education and were associated with all the three technical institutions of Durgapur for some time in their career. The experts were requested to do pair wise comparisons among factors and identify the level of importance of one over the other using the scale mentioned in Table 1. To do that a set of questionnaires were provided to the experts.

2.3 Identification of factors and sub factors for evaluating alternatives

The factors and sub factors in the performance evaluation of a technical institution (under AICTE in India) is available in the format mentioned by National Board of accreditation (http://www.nba-india.org). Since this set of factors and sub factors are well established and are evaluated in the NBA accreditation process in India, the researcher relied on the same set of factors while doing this study. Since this study

is restricted to technical institutions only, expert's opinions were sought to shape the final selection of the factors and sub factors for the study. They are listed within the hierarchy in figure 2.

2.4 Selection of alternatives

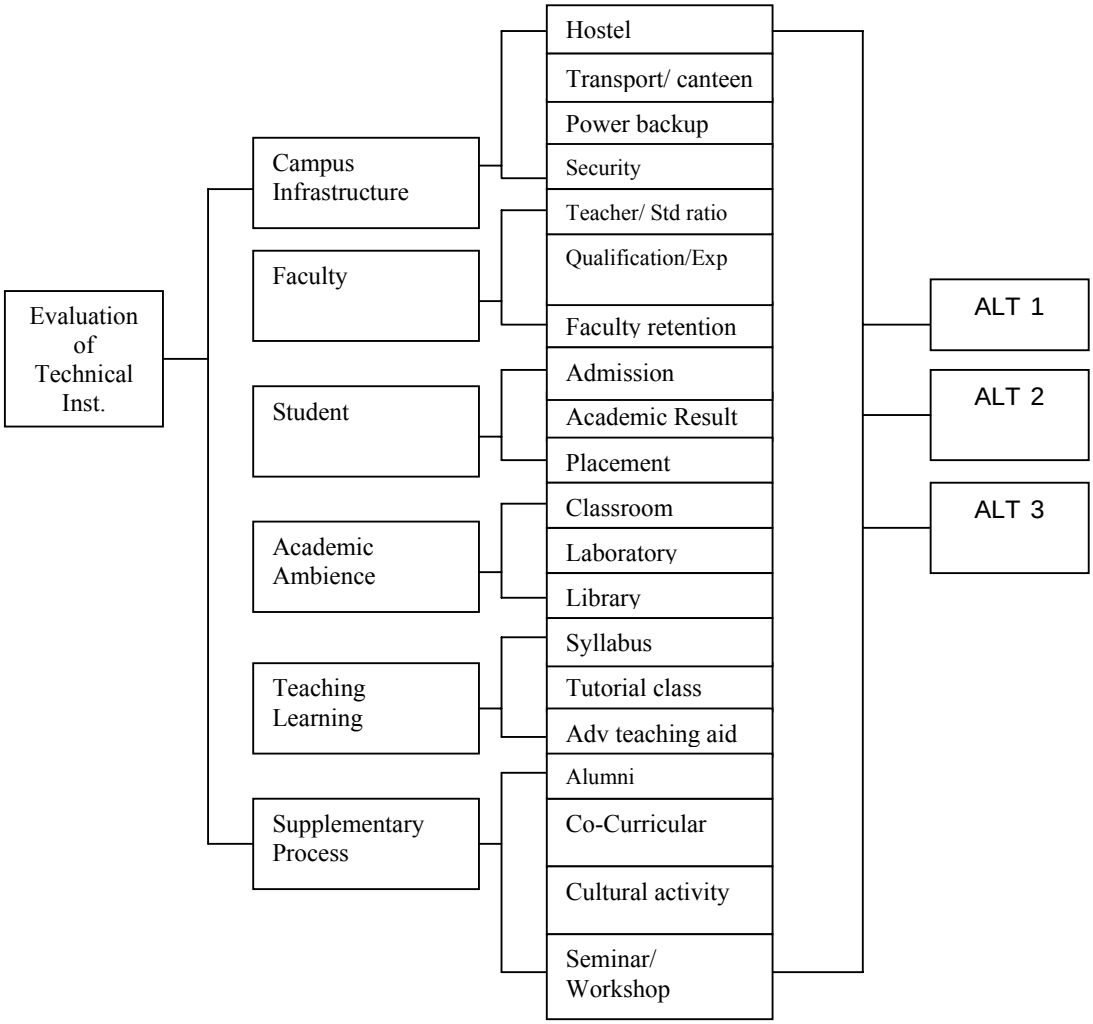
There are around eight technical Institutions in the sub division of Durgapur, West Bengal (Educationinfo, 2011). Two are government institutes and three private institutes came very recently. Remaining three self financed technical institutions are selected as alternatives in this study. One can easily argue why all the existing institutions were not taken into consideration. The answer is simple. All the three select institutions are established on or before 2002, i.e. they are providing engineering education for a decade or more and around two thousand students graduated from those institutions each. The year of establishment is taken as factor for short listing the alternatives as it indicates that all of them are in the growth phase and they survived infancy. Moreover, the government institutions were not selected because they do have a different funding and previous studies criticized the comparison of institutes having significant variation in funding (Bengoetxea et al, 2012). Although there is no restriction on the number of alternatives considered in a study using AHP, but due to its huge computational size and to better explain the technique three alternatives were considered. The names of the institutions are disguised as Alternative 1, Alternative 2 and Alternative 3 for the smooth conduct of the study.

2.5 Construction of the detailed hierarchy of the problem

The hierarchy in the problem is structured keeping the objective at the top (performance evaluation of technical institutions) through the intermediate levels (main and sub-factors on which subsequent levels depend) to the bottom level (the list of technical institutions as alternatives). Figure 2 describes the hierarchy in detail.

Figure 2

The detail hierarchy of the problem



2.6 Generation of factor weight and score for alternatives

In order to generate factor weight and alternative scores two sets of questionnaire containing 39 and 60 questions were administered to the experts. The responses were captured using the scale mentioned in table 2. In this paper the factor and sub factor weights are generated through row average of the normalized pair wise comparison matrix followed by a consistency test which takes care of the inconsistencies of the judgments. This method (AHP) is widely used and introduced during 1980's by T.L Saaty. The process (AHP) is done using the following steps:

- Step 1: Calculate the relative weights of the factors compared in the comparison matrix and calculate the column average of the row means. $\lambda_{average}$ indicates the column average value.
- Step 2: Compute the consistency index (CI) for each matrix of order n by the formulae: CI = $(\lambda_{average} - n)/(n-1)$. This consistency test validates the responses taken into the model.
- Step 3: The consistency ratio (CR) is then calculated using the formulae: CR = CI/RI, where RI is a known Random Index. Tables 2 show the value of the random index (RI). A response is considered valid if the value of CR is found to be less than 0.1.

Tables 2

Random index (RI) table

n	3	4	5	6	7	8	9	10
R.I	0.58	0.89	1.12	1.25	1.35	1.42	1.46	1.49

2.7 Calculation of overall score for alternatives

After the weights of the different factors and sub factors are evaluated and tested for consistency, each of the factor weights got multiplied to the corresponding sub factor weights to generate global weights S_l and the overall score of mth alternative is obtained by A_m, where

$$A_m = \sum_{l=1}^{N} s_l \times a_{ml} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

s_l is the weight of lth sub factor and a_{ml} is the weight of mth alternative with respect to l^{th} sub factor.

3. Results and Discussion

Once the hierarchy was established and a series of questions were asked to direct pair wise comparisons, each expert judgment was captured and converted to factor weights using step 1 and 2 of section 2.6. The main factor weights are expressed in Table 3.

Table 3
Main Factor weights

Factor	Weights
Campus Infrastructure	0.26
Faculty	0.32
Student	0.20
Academic Ambience	0.09
Teaching Learning Process	0.08
Supplementary Process	0.05

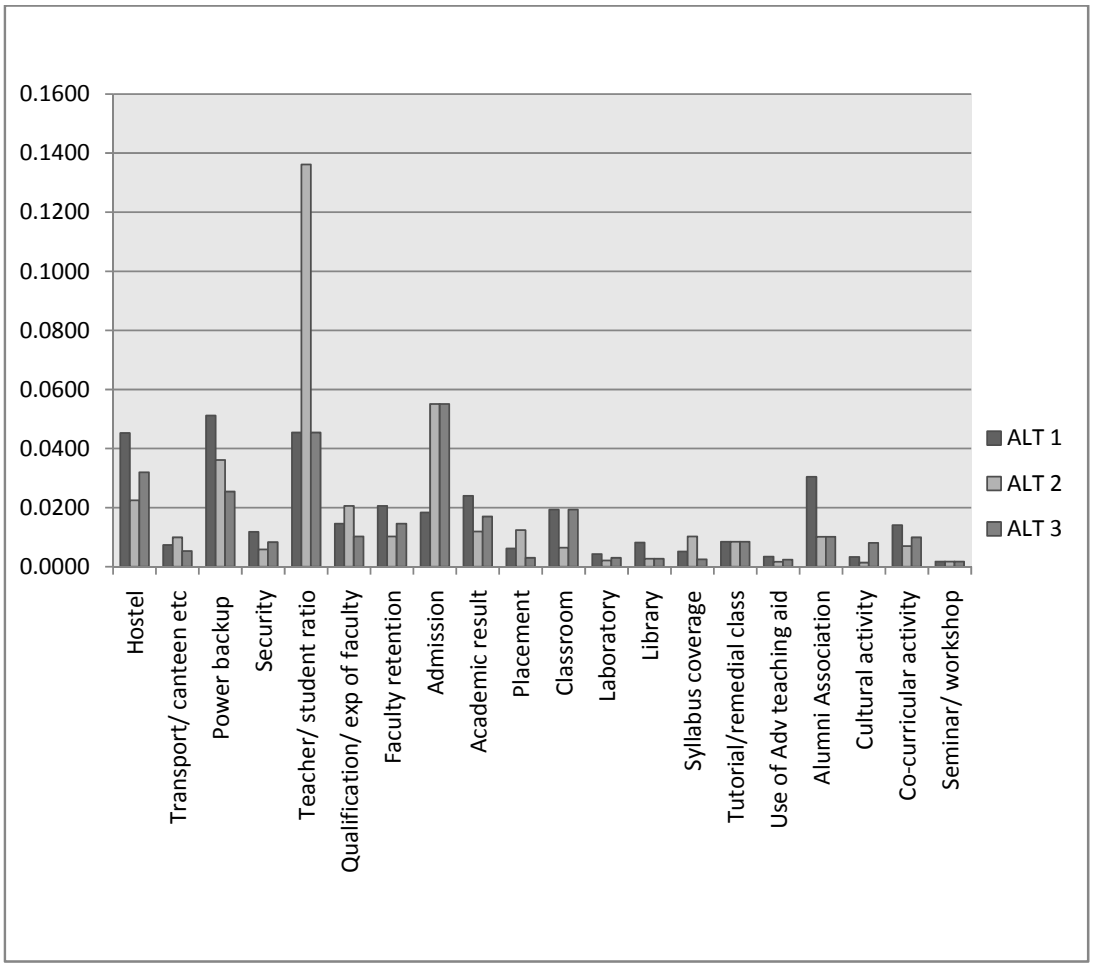
Table 3 shows that 'faculty' contributes maximum among the factors considered. From the evaluation of the sub factors it is observed that power backup, number of faculty to student ratio, laboratory, admission process, teaching pedagogy and alumni association happens to be the most important sub factor under the corresponding factor. Table 4 provides a detail of the sub factor and global sub factor weights.

Table 4
Sub factor weights

Sub Factor	Weights	Global weight	Sub Factor	Weights	Global weight
Hostel	0.3820	0.09967	Classroom	0.2605	0.04510
Transport/ canteen etc	0.0864	0.02254	Laboratory	0.6333	0.00938
Power backup	0.4320	0.11272	Library	0.1062	0.01360
Security	0.0996	0.02598	Syllabus coverage	0.3033	0.01790
Teacher/ student ratio	0.7143	0.22695	Tutorial/remedial class	0.0897	0.02536
Qualification/ exp of faculty	0.1429	0.04539	Use of Adv teaching aid	0.6070	0.00749
Faculty retention	0.1429	0.04539	Alumni Association	0.5246	0.05074
Admission	0.6333	0.12853	Cultural activity	0.1091	0.01273
Academic result	0.2605	0.05287	Co-curricular activity	0.1582	0.03094
Placement	0.1062	0.02154	Seminar/ workshop	0.2082	0.00519

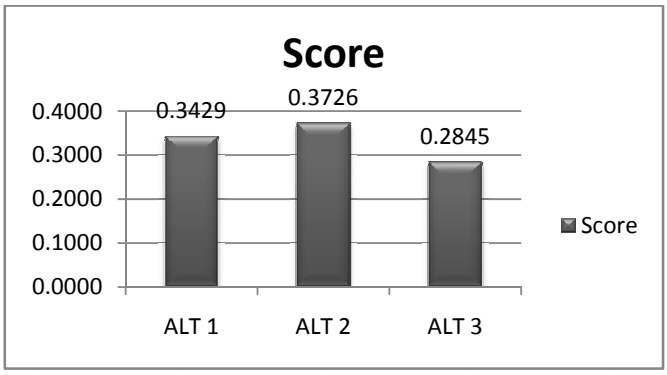
Looking at the alternatives with respect to the sub factor it shows that in infrastructure Alternative 2 is leading with Alternative 1 in the second position, in admission, Alternative 3 is positioned significantly below both the Alternatives 1 and 2, where as the opposite picture exists when it comes to alumni association. Figure 3 explains the position of different alternative institutions with respect to the sub factors considered.

Fig 3
Scores for the alternatives



From the aggregate score shown in Fig 4 it can be observed that the Alternative 2 leads with Alternative 1 in second position.

Fig 4
Overall score of the alternatives



4. Conclusion

Selecting an institute for quality education is really a problem in India in particular as the numbers of private self financing institutes are multiplying every year. It is also difficult to find an 'all size fit' model for ranking various technical institutions with diverse objective (Sengupta, 2006). A survey of human resource professionals at multinational corporations in India revealed that only one quarter of engineering graduates with a suitable degree could be employed irrespective of demand (Farrell et al, 2005). At this outset the stakeholders are in need of a quantified evidence of quality of an institution without going too much into the working (Sadlak, 2010). Even though many studies revealed that media rankings do have inconsistencies (Stella et al, 2006), it at least can help the stakeholder gather data that was not accessible before. Along with the International Ranking Expert Group (IREG), researchers also criticized the 'all size fit' ranking models and proposed to follow guidelines mentioned in berlin principle (Cheng et al, 2008). The present study used AHP in evaluating three technical institutions having equivalent mission, size, geography and funding. Here the objective was to rank the alternative institutions using a multidimensional evaluation method. After obtaining the weights and priorities of the factors considered in the study an attempt has also been made to validate the model. Ranking of quantitative parameters like faculty ratio, placements, academic results, library details, seminar/ workshops conducted across alternative institutions are also verified using the 'AICTE mandatory disclosure' kept in the websites of the respective institutions. Since the method used was completely perception based, the results being in line with the data available in the mandatory disclosures of the respective institutions ensured the validity of the overall

model. Also it is to be noted that this method has nothing to do with statistics and checking statistical validity is irrelevant. Interestingly, the method is best suited for prioritization where very little or no data is available regarding the factors and sub factor.

Despite the huge applicability of this model, its usage is limited to studies involving less number of factors, sub factors and alternatives because of the computational size. The applications of AHP are also dependent on the choice of the expert as the model is based on subjectivity and hence wrong choice of expert can be detrimental to the study. Adding to that, expert opinions often suffer from 'hallo effects' as well. Often one department's reputation can influence the rating of the whole institution (Stella et al, 2006).

Although this study evaluates the institutions as a whole, one can consider different departments within the technical institution and rank departments across different institutions for a more detailed study.

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About Author

Debmallya Chatterjee
Assistant Professor
Area: Operations Management
Education: M.Tech (NIT-D), MSc(Univ. of Burdwan), MIT(MAHE), PhD (pursuing)
Telephone: +91-820-2701023
Email: debmallyac@tapmi.edu.in

Teaching: Operations Research, Application of Quantitative methods in Management, Business Statistics, Discrete Mathematics, Business Mathematics, Mathematical Analysis, Problem solving and decision making.

Professional Activities: He obtained his Masters of Technology (Mtech) on 'Operations Research in Industry and Business management' from NIT Durgapur. Prior to that he got his masters in Mathematics from University of Burdwan and Masters of Information Technology from Manipal academy of higher education. He is in academia for last eight years.

Research: Research interest is in the field of Fuzzy mathematics, Analytical hierarchy process and its application in business, Systems thinking tools in creative decision making.

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1. Sinha, T.R., Chatterjee, D.and Iskanius, P. (2011) 'Measuring stress among hospital nurses: an empirical study using fuzzy evaluation', Int. J. Logistics Economics and Globalisation, Vol. 3, Nos. 2/3, pp.142–154.
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Conference Presentations:

1. Presented a paper entitled "A Fuzzy-AHP evaluation of performance Appraisal: A case study on Peerless general finance corps. ltd, kolkata" at the UGC sponsored National seminar at BB College, Asansol, W.B on 19th – 20th Feb, 2010
2. Presented a paper entitled" Measuring service quality gap: A case study on City Residency Hotel, Durgapur" at The Department of Business Administration, North Bengal University on 29th -30th March, 2010

Awards & Recognitions

1. “Outstanding service 2010” Rahul Foundation, Rajbandh, Durgapur-12, West Bengal

2. “Best Faculty 2004-2005” Rahul Foundation, Rajbandh, Durgapur-12, West Bengal