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A framework to measure relative performance of Indian technical institutions using integrated fuzzy AHP and COPRAS methodology

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ABSTRACT

There are many opportunities and challenges in area of Indian technical education due to liberalization and globalization of economy. One of these challenges is how to assess performance of technical institutions based on multiple criteria. This paper is focused on performance evaluation and ranking of seven Indian Institute of Technology (IITs) in respect to stakeholders' preference using an integrated model consisting of fuzzy AHP and COPRAS. Findings based on 2007–2008 data show that performance of two IITs need considerable improvement. To the best of our knowledge it is one of few studies that evaluates performance of technical institutions in India.

1. Introduction

To make India a knowledge based society the most important area that needs to be addressed first is education. No society or no nation can be developed without proper education. As envisaged by Indian erudite scholars around 1000 years ago, education is a never ending journey from less light to more light (*Tamaso Ma Jyotirgamaya*). Education is the manifestation of perfections already in man.

Indian technical education system is one of the largest educational systems in the world. Engineering education in India started during the British colonial rule and it focused mainly on civil engineering. Gradually few engineering colleges namely the Engineering College at Roorkee, Poona Civil Engineering College at Pune, Bengal Engineering College at Shibpur, etc., came up in the mid-1850s. Presently, the technical education system in the country can be broadly classified into three categories like, Central Government funded institutions, State Government/State funded institutions and Self-financed institutions. In 2007–2008, there were 52 centrally funded institutions (CFI) of technical and science education. The breakup of these 52 institutions is furnished in Table 1. These institutions function following the guidelines stipulated by All India Council for Technical Education (AICTE) and the Council of architecture. As of now 2300 engineering colleges are running in India and 600,000 students are passing out in each year [9].

In the list of the best technical institutes in India, the first name comes into sight is a group of institutions called Indian Institute of Technology (IITs). The purpose of this paper is to assess the relative performance of these IITs based on multiple criteria. In this paper, we have considered seven Indian Institutes of Technology (IITs) located at Kharagpur, Bombay, Madras, Kanpur, Delhi, Guwahati and Roorkee for study and these are coded as A, B, C, D, E, F and G respectively. These institutions are declared as "institutions of national importance". The main objective of IITs is to impart world class education in engineering and technology, to conduct research in the relevant field, and to further advancement of learning and dissemination of knowledge.

As the uniform quality output has become the prime concern today, therefore, performance evaluation and ranking of these technical institutions have become a research issue. All the stakeholders want to get optimum benefits at shortest period of time and at an economical cost to improve the quality of life. Therefore, this is the high time to do the performance evaluation of the technical institutions. In the literature lot of research works that deal with the performance evaluation of academic institutions worldwide have been reported in the last thirty years. Several approaches have been applied for this purpose like performance indicators, parametric methods (such as ordinary least square method, stochastic frontier method) and non-parametric method – such as various data envelopment analysis

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Table 1
List of centrally funded institutions.

Name of the institutions	Number of institutions
Indian Institutes of Technology (IITs)	7
Indian Institutes of Management (IIMs)	7
Indian Institute of Science (IISc), Bangalore	1
Indian Institutes of Science, Education & Research (IISERs)	3
National Institutes of Technology (NITs)	20
Indian Institutes of Information Technology (IIITs)	4
National Institutes of Technical Teachers' Training & Research (NITTTRs)	4
Others	6
Total	52

(DEA) models. Each method has its strength and limitations. For single input and single output case the ratio style performance indicators can work well. But when multiple criteria (which may be conflicting in nature) exist, it is unable to draw right inference. Parametric methods require explicit functional form for technology. In this paper we suggest an integrated fuzzy multi-criteria decision making model consisting of fuzzy analytic hierarchy process (AHP) and compressed proportional assessment (COPRAS) to assess the relative performance of the IITs. The contribution of the present work is that, this model is robust; it is easy to deal with; complex mathematics is not required and the evaluation criteria encompass stakeholders' preference. Computation of the degree of relative importance for evaluation criteria is made through fuzzy AHP. COPRAS method helps to compute an overall score and ranking for each IIT for the decision maker to select the best alternative based upon multiple criteria that may be conflicting in nature.

The paper is organized as follows: Section 2 reviews the earlier literature. Section 3 describes application procedure of proposed model used in the paper. Section 4 gives information about data and computation. Section 5 summarizes the discussion. In the last section conclusion is given.

2. Review of the literature

During the past two decades lot of studies dealing with university evaluation (that includes academic departments, university libraries or university as a whole) have been published. Most of the studies have focused on UK or Australia. Research on universities in the UK include those by Athanassopoulos and Shale [5], Glass, McKillop and Hyndman [23,24], Johnes [29,30] and Johnes and Johnes [28], Casu and Thanassoulis [12], Flegg et al. [22]. In UK Portela and Thanassoulis [46] have investigated the efficiency of schools also. Plenty of studies have been reported on efficiency analysis of Australian universities. Among the authors who have written about it we can mention Avkiran [6], Abbott and Doucouliagos [1], Madden, Savage and Kemp [41], Coelli [18], Worthington and Lee [54], etc. Kao and Hung [34] have concentrated on performance evaluation of academic departments in Tiwan. Ahamadi et al. [3] have evaluated 140 academic departments in Tehran University. Lee [39] proposes a conceptual model to evaluate intellectual capital (IC) indicators for performance assessment of Taiwanese university. Fandel [21] makes a study on German Universities. Korhonen, Taino and Wallenius [35] analyse 18 research units at Helsinki school of Finland. Elsewhere Hashimoto and Cohn [25] have investigated Japanese universities, McMillian and Debasish [43] and McMillan and Datta [42] have investigated Canadian universities. Abramo, Cicero and D'Angelo [2] have investigated Italian universities. Li [40] has analyzed Chinese universities. Pouris and Pouris [47] have analyzed South African universities. Kuah and Wong [36] present a simple application of DEA for evaluation of 30 universities. In India, Tyagi et al. [52] have done similar study dealing with assessment of academic departments of IIT Roorkee. Research works on assessment of university libraries [48,51,55] are also found in literature.

All the study mentioned above use various DEA models for the purpose. A brief summary of literature review on university evaluation using DEA is shown in Table 2. However some applications of other models for performance evaluation in academic field are also found. Nicholls and Cargill [44] propose a mixed mode modeling approach along with a solution heuristic to represent university research funding problem. Bana e Costa and Oliveira [7] propose a multicriteria decision analysis model for faculty evaluation. In this paper, we propose an integrated fuzzy MCDM model for performance evaluation of IITs. In Indian context we are doing it first time to the best of our knowledge.

3. Research design

3.1. Selection of evaluation criteria

The performance of technical institutions in absolute sense is very difficult to measure. There are lot of factors/criteria/attributes/objectives those affect the performance of the institutions and the measurement result is very much sensitive to the selection of the criteria. In the literature mentioned above, the criteria are categorized either inputs or outputs to conform to DEA algorithms. Thus, the selection of criteria plays a crucial role in performance evaluation. According to Barros [8] "…the criterion of available data is frequently used, since it encompasses the other two criteria applied to the selection of the determinants. The first of the two is the literature survey, which is a way to ensure validity of research and therefore a criterion to take into account. The remaining criterion for measurement selection is the professional opinion of senior management". Table 1 outlines inputs and outputs used in the literature of relative efficiency studies using DEA.

For our research we form an expert committee consisted of 15 experts in the field of teaching at UG/PG level, academic planning & administration and industry management responsible for providing employment. We prepare a questionnaire containing fifty questions related to criteria selection and the same was circulated among the experts. Aggregating their views by doing pareto analysis following criteria are short listed for the study. Also, the expert committee helps us to determine the relative importance of criteria through fuzzy AHP.

- Faculty strength (FS).
- Student intake (SI).
- Number of Ph.D. awarded (Ph.D.).
- Number of patents applied for (Patent).
- The campus area in acres (CA).
- Tuition fee per semester (TF) in rupees.

Instead of classifying the criteria into output and input, in our study we call these either beneficial or non-beneficial criteria respectively. Fig. 1 shows the classification of criteria. In most of the literatures faculty strength and student intake are considered as inputs whereas we consider them beneficial criteria i.e., higher the better according to Taguchi's concept. The reason is that India is the second most populous country in the world. This country is blessed with the availability of human resources in the working age group. The challenge before the country today is that this available manpower has to be made