World Transactions on Engineering and Technology Education
Vol.3, No.2, 2004

A prediction of the accreditation status of engineering programmes in India: a logistic regression approach

Kanakkancheriyil G. Viswanadhan, Nalath J. Rao & Chiranjith Mukhopadhyay

Indian Institute of Science
Bangalore, India

ABSTRACT: The National Board of Accreditation (NBA) in New Delhi, India, has developed a process to assess the technical education programmes in India. Obtaining a good accreditation status is essential for establishing a high position in the technical education field; this is apart from being an issue of prestige for most of the ambitious engineering colleges in India. In this article, the authors discuss the development and validation of a model for predicting the accreditation chances of an undergraduate engineering programme in India through the NBA accreditation process by using the statistical technique, logistic regression.

INTRODUCTION

With rapid progress in the information and communication technologies over recent years, the demand for a technical workforce in these areas has also increased. This situation is also reflected in India. This has resulted in the establishment of a large number of institutions throughout India that offer a variety of programmes towards meeting this demand. As the number of engineering colleges increases, the quality of education provided by them also is brought more into the spotlight. Thus, a mechanism to identify the programmes of technical institutions that meet some specified norms, standards and criteria have become essential for stakeholders of engineering education in India.

Various frameworks for the assessment and assurance of quality are in practice in the USA and the European Union (EU). A benchmarking project covering engineering education has reported on successful practices (ie concepts, methodologies and tools) in specific areas of engineering education that have proved successful according to the defined criteria [1]. Indeed, 95 potentially valuable practices were identified, of which 31 successful practices were verified and analysed in detail in the report. Elsewhere, 10 principles about learning and how to reinforce it have been drawn from research and practice, and reported by the American Association for Higher Education [2]. The result of a faculty survey of *Teaching Practices and Perceptions of Institutional Attitudes Toward Teaching* in an eight-campus coalition of engineering schools was published after conducting three rounds of surveys [3]. This survey gave insights into the importance of various factors like active learning, team assignments, technology-based instruction, writing assignments, instructional objectives and study guides, faculty development, and the rated importance of teaching quality and innovation from the opinions of the faculty.

ISO 9000 is another framework and is a procedural approach to quality assurance [4]. Here, the standard of quality is defined according to stated and implied customer requirements, with procedures written and followed in order to ensure that customer requirements are consistently delivered. The claimed benefits of ISO 9000 include more rigorous systems and operational measurement, while the drawbacks have been defined as increased bureaucracy and decreased flexibility [5].

A more detailed framework for quality measurement has been detailed in the *Malcolm-Baldrige National Quality Award Program* [6]. The Baldrige Education Criteria are being used increasingly by education organisations in the USA to improve their performance. The Criteria have been built upon a set of interrelated core values and concepts that have been embodied in seven categories, namely:

- Leadership;
- Strategic planning;
- Student, stakeholder and market focus;
- Measurement and analysis;
- Knowledge management;
- Faculty and staff focus;
- Process management and organisational performance results.

In the USA, the Accreditation Board for Engineering and Technology (ABET) is responsible for the specialised accreditation of educational programmes in engineering, engineering technology and engineering-related fields [7]. The ABET follows a combination of a resources approach and a process approach for their accreditation process [8].

These frameworks have been implemented in engineering programmes in the USA and European countries, offered by autonomous organisations (universities), which can plan and

structure all the activities connected with the programme independently, starting from the statement of goals until the assessment of their accomplishment.

Indian Context

However, in India, where hundreds of colleges are affiliated to one university, these approaches are not readily applicable. In India, the National Board of Accreditation (NBA) is assigned with the task of ensuring the quality of education offered by various programmes. The NBA is now in the process of accrediting the programmes of technical institutions in India. Around 1,000 undergraduate engineering programmes have been accredited to date and more programmes are on the way to realising the accreditation process.

Gaining a good accreditation status is essential in order to establish a prominent position in the technical education field; this is apart from being an issue of prestige for most of the ambitious institutions engaged in this process. Thus, a study of the inner details of the accreditation process for developing a simpler method for predicting the chance of becoming accredited, before actually going through the accreditation process, would be of paramount importance to these institutions. Hence, the present study has been undertaken in order to determine an alternative and simplified model that can predict the chance of getting accredited through the NBA process.

THE ACCREDITATION PROCESS OF THE NBA

The NBA has formulated the criteria or standards, by which individual programmes in any institution will be judged, so as to give an indication of the strengths and weaknesses of the programmes. These are classified into eight criteria that measure the quality of different aspects of the programme. These criteria are as follows:

- Mission, goals and organisation;
- Financial and physical resources and their utilisation;
- Human resources: faculty and staff;
- Human resource: students;
- Teaching-learning processes;
- Supplementary processes;
- Industry-institute interaction;
- Research and development (R&D) activities [9].

Under each criterion, several variables are included to measure the performance. Those institutions that wish to accredit their programmes submit this information and data according to the performa provided by the NBA. The NBA then identifies a chairperson and the members of the visiting team for the accreditation of the programme. The expert team selected by the NBA then visits the institute and conducts discussions with management, the principal, faculty, supporting staff, students and other stakeholders in order to assess the performance of the programmes. Within two weeks of its visit, the visiting team submits a report giving the facts, observations, assessments, conclusions and recommendations to the sectorial committee concerned. The report covers its observations and conclusions pertaining to the institution's commitment to its goals, the objectives and contents of the curricula, faculty and students, administration, its financial position and other relevant factors that affect the quality of education.

After considering the report of the visiting team and the sectorial committee's observations, the NBA announces whether or not the programme has been accredited. The allotments of grades are based on the total points acquired by the programme [10]. The grading systems for the earlier and current accreditation process of the NBA are given in Table 1.

Table 1: The grading system of the NBA.

Total Points (Out of 1000)	Grades allotted – Earlier System	New scheme of evaluation (From 1 January 2003 Onwards)
> 750	A	Accredited for 5 years
650-750	B	Accredited for 3 years
550-650	C	Not accredited
< 550	Not accredited	

DATA COLLECTION

The reports about the performance of 49 engineering programmes from various parts of India, as submitted by the NBA expert teams who visited the programmes during the 2000-2001 period, have been collected. The programmes come under four categories, as follows:

- 20 owned by the Central Government;
- 11 owned by the State Government;
- 10 in the aided sector;
- 8 under the self-financing scheme.

Among the 49 programmes, 32 scored 650 or more points in the accreditation process. The remaining 17 programmes scored less than 650 points. Hence, 32 programmes are taken as being *accredited* and the other 17 being as *not accredited* according to the new criteria. Information about the 35 programmes is being used for the model structure and data for the remaining 14 programmes are being used to validate the model. Both the model structure and validation data set contain both *accredited* and *not accredited* programmes.

For the accreditation process of engineering programmes, the NBA has identified 70 variables to measure the eight major criteria. As the allotment of points to these 70 variables is not based on any measurement technique, using a well-structured questionnaire, the allotted points may not be accurate. The allotments are rather subjective in nature. The usual tendency in such a situation is to allot points to the major eight dimensions and split these scores subjectively to the individual variables so as to tally the total points. Hence, instead of 70 individual variables, the major variables of the NBA have been taken as the independent variables for the model structure. The accreditation status (accredited – 1 and not-accredited – 0) of engineering programmes is the dependent variable in the model.

MODEL STRUCTURE AND VALIDATION

Regression methods have become an integral component of any data analysis concerned with describing the relationship between a response variable and one or more explanatory variables. It is often the case that the outcome variable is discrete, taking on two or more possible values. In the accreditation process, the discrete outcome variables are *accredited* and *not accredited*. Over the last decade, the logistic

regression model has become the standard method of analysis in this type of situation for many fields [11].

Models of Perfect Fit

The accreditation process of the NBA follows an additive model. The total points scored by a programme are calculated by summing up the individual scores of the major eight variables. If the scores of all individual variables can be determined using some measurement technique, then there is no difficulty in predicting the accreditation status. So, a model involving large number variables does not have any value. Hence, attempts have been made to develop a model that contains a minimum number of variables and is capable of making the prediction with maximum accuracy.

A backward elimination method has been followed to achieve this target. It has been found out that a minimum of two variables is required to provide a model of perfect fit for predicting accreditation status.

The classification results of the model structure data set and the validation data set are listed in Table 2. Even the classification results show perfect fit (100%) in the parameter estimate, although the estimated standard error of the calculated coefficients seems to be very large compared to the point estimate. This might be the result of a complete separation of the outcome groups that have occurred due to a surplus number of variables included in the model. There might not be any overlap in the distribution of the covariates between the two outcome groups and hence maximum likelihood estimate does not exist in this situation. Subsequent results shown are based only on the last iteration.

The validity of model fit is uncertain. Hence, another data set was utilised to test the validity of the model. The models exhibited a good amount of accuracy (93, 93 and 86%, respectively), which is visible in the classification results (see Table 3).

The model equations are as follows:

- *Model 1*: g (x) = 4,830.77 – 73.310 * (Mission, Goals and Organisation) – 16.22 * (HR: Students);
- *Model 2*: g (x) = 1,498.64 – 15.75 * (Mission Goals and Organisation) – 2.88 * (Teaching-Learning Process);
- *Model 3*: g (x) = 4,407.83 – 20.76 *(HR Faculty) – 29.99 * (HR: Students).

The chance that the main effects model demonstrates complete separation increases with the number of variables included in the model. In order to have finite maximum likelihood estimates, there must be some overlap in the distribution of covariates in the model. As the models with two variables show chances of separation, attempts were made to build a reliable model using a single variable.

A prime component analysis of the NBA data yields only a single component that can be called the *Overall Performance of the Programme* (Table 3). As the calculation of this component score requires all eight values, the model structure using this component is not helpful. However, this result of the main component analysis gives a clear indication that the entire NBA process can be explained by a single component.

Table 3: The PCA results of the NBA data.

Variables	Component	Communality
Mission, Goals and Organisation	0.880	0.723
Financial &Physical Resources and their Utilisation	0.850	0.476
Human Resources: Faculty& Staff	0.848	0.550
Human Resources: Students	0.787	0.775
Teaching – Learning Processes	0.780	0.609
Supplementary Processes	0.742	0.619
Industry – Institution Interaction	0.739	0.720
Research & Development	0.690	0.549
Eigen Values	5.018	
Percentage of Variance	62.728	

Therefore, attempts have been made to model the process using a single variable. A forward selection using the *score test* and elimination selection using the likelihood ratio test were conducted. The first criterion, *mission, goals and organisation*, came out as the best variable to represent the accreditation process. The model significance was measured through a chi-square statistic, which was the difference of -2 Log likelihood between the final model and a null model (ie a model with intercept terms only). Here, the p-values were 0, indicating that fits of the models were significantly adequate. The likelihood ratio test (see Table 4) showed significance of each variable in the model. Here, the variable significance was tested

Table 2: Model structure information and classification results of the perfect-fit models.

Model		Parameter Estimation		% Correct (Model Data)	% Correct (Validation Data)
		B	Std. Error		
1	Intercept	4,830.7	0	100	93
	Mission, goals and organisation	-73.31	2,259.8		
	HR: students	-16.22	2,272.4		
2	Intercept	1,498.6	0	100	93
	Mission, goals and organisation	-15.75	2,625.9		
	Teaching-learning process	-2.88	537.26		
3	Intercept	4,407.8	0	100	86
	HR: faculty	-20.76	442.59		
	HR: students	-29.99	974.42		

Table 4: Likelihood ratio test for the single variable model.

Model	Likelihood Ratio test			
	-2 log Likelihood of reduced Model	Chi Square	df	p
Intercept	25.11	17.61	1	0
Mission, goals and organisation	28.56	21.06	1	0

through a chi-square statistic, which was the difference between the full model and the model excluding that particular variable.

The estimated logit is:

g(x) = 26.337 - 0.497 * (Mission, goals and organisation)

The model prediction is accurate for 88.6% of the observed data in the model structure data set. The result of prediction in the validation data set yields an accuracy of 85.7%. The details of the model building information and classification results are presented in Table 5.

Table 5: model building information and classification results of the single variable model.

Model	Parameter Estimation		% Correct (Model Data)	% Correct (Validation Data)
	B	Std.error		
Intercept	26.34	12.201	88.60	85.71
Mission, goals and organisation	-0.497	0.229		

CONCLUSIONS

A study has been undertaken in order to identify a simplified model that can predict the chance of an undergraduate engineering programme becoming accredited through the accreditation process of the National Board of Accreditation (NBA).

Four models have been developed utilising the logistic regression technique. Their significance and validity have been tested using statistical methods and have been found to be satisfactory.

REFERENCES

1. Successful Practices in International Engineering Education (SPINE), Benchmarking of Engineering Education. Switzerland: SPINE (2002).
2. American Assoc. for Higher Education (AAHE), Powerful Partnerships: A Shared Responsibility for Learning: a Joint Report. Washington, DC: AAHE (1998).
3. Southeastern University and College Coalition For Engineering Education (SUCCEED), SUCCEED – Faculty Survey of Teaching Practices and Perceptions of Institutional Attitudes toward Teaching. Gainesville: SUCCEED (2000).
4. British Standard Institution (BSI), Education and Training: Guidance Notes on the Application of BSEN ISO 9001 for Quality Management Systems in Education and Training. London: BSI (1995).
5. Moreland, N. and Clark, M., Quality and ISO 9000 in educational organizations. *Total Quality Management*, October-December (1995).
6. Baldrige National Quality Programme (BNQP), Educational Criteria for Performance Excellence. Gaithersburg: BNQP (2003).
7. Accreditation Board for Engineering and Technology (ABET), Engineering Criteria 2000: criteria for accreditation programs in engineering in the United States. *ASEE Prism*, 6, 41-42 (1997).
8. Aldridge, D.M. and Benefield, L., A planning model for ABET Engineering Criteria 2000. *Proc. Frontiers in Educ. Conf.*, Pittsburgh, USA, Session F4A, 988-995 (1997).
9. All India Council for Technical Education (AICTE), Manual for NBA Accreditation. New Delhi: AICTE (2000).
10. National Board of Accreditation (NBA), Sectorial Committee Report. New Delhi: NBA (2000).
11. Hosmer, D.W. and Lemeshow, S., *Applied Logistic Regression.* New York: John Wiley & Sons (2000).