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QUALITY IN EGYPTIAN HIGHER EDUCATION CONTEXT: DEA APPROACH TO ENHANCEMENT OF INTERNAL QUALITY ASSURANCE SYSTEMS IN TECHNICAL DEPARTMENTS

Key Words

Egyptian Higher Education; Efficiency; Data Envelopment Analysis (DEA); Internal Quality Assurance Systems; Service Quality; Input/output; Technical Education; Mansoura University.

Abstract

This paper outlines the results of a study aimed to propose a new managerial instrument for performance enhancement of internal quality assurance systems and employ Data Envelopment Analysis (DEA) to estimate efficiency scores for technical departments. The input measures are constructed from Student Support, Teaching and Learning Methods, Facilities required for teaching and learning, curriculum, administration, and staff development, whereas the output measures are based on Intended Learning Outcomes (ILOs), quality of learning opportunities, and student achievement. Using frontier analysis, we were able to separate technical departments that might qualify, as good performers, from those who require improvement. A new managerial instrument treats quality enhancement as the relative comparison of a number of comparable Departmental Decision-making Units (DMU's). The evidence suggests that the DEA technique can help achieve national optimal levels of quality dimensions that are directly linked to critical performance outcomes for technical departments. This could imply better allocation by the university of the scarce public financial resources available to higher education institutions (HEIs), and enhancement of internal quality assurance systems.

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Introduction

In a speech at the joint session of the people's assembly and Shoura Council 2004, President Hosni Mubarak stressed the importance of quality assurance and accreditation in education. The Ministry of Higher Education, being responsible for the overall education system in Egypt as stipulated in the constitution, took the initiative to develop an overall strategic plan for quality assurance and accreditation to assist Egyptian Higher Education Institutions (HEIs) to enhance the quality of their academic programs and that of their graduates (NQAAC, 2004). The National Quality Assurance and Accreditation Committee (NQAAC) in collaboration with British consultants in higher education along with local expertise developed the Quality Assurance and Accreditation Project (QAAP) which included 25 projects agreed upon by the National Higher Education Conference in 2000. The QAAP has also been chosen as one of the six Higher Education (HE) development projects implemented by the end of the year 2002 (MOHE, 2004).

NQAAC developed guidelines and procedures required for the development of internal quality assurance systems to take place in all Egyptian Higher Education Institutions. The system which is adopted by the institution aims to improve the level of the educational programmes and other elements affecting them. Such a system involves performance follow-up, suggestions for development and enhancement, programme evaluation, strategic objectives, student assessment, teaching and learning methods, facilities and teaching materials, results of students' course evaluation, and course enhancement (NQAAC, 2004). The Ministry of Higher Education and State for Scientific Research (MHESR) believe that the Quality Assurance Project is not a project or a process, but it is a culture and should be the ensemble of elements of higher education enhancement (MOHE, 2004). For that, MHESR developed procedures required for quality enhancement in Egyptian Higher Education through two enhancement plans (Tempus, 2008). According to the MOHE, (2004) the first plan was called National Higher Education Reform Plan, and resulted in a Strategic Reform Plan for Higher Education. It included 25 Distinct Reform Projects, with an implementation plan date between 2002- 2007. First phase contains 6 major fields covering 12 reform projects. The second phase for enhancement was the 2006 Updated National Reform Plan, Strategic Planning (Master Plan) 2007-2022, Implementation Plan (Second Phase

2007-2012) (MOHE, 2004). The elements of quality assurance in the higher education enhancement plan adopting an integrated approach to quality assurance to achieve international quality standards in higher education. It included; quality assurance systems, competitiveness in higher education, staff and leadership skills development, advanced technical education, ICT infrastructure, and international cooperation in higher education (Tempus, 2000).

QAAP/ QAAP2/ CIQAP Projects for Quality Assurance Systems established Internal Quality Assurance System in 250 out of the 320 colleges, preparation of colleges for the quality enhancement and qualification for accreditation, (CIQAP) in 50 colleges, and allocated a budget for the preparation for accreditation (Tempus, 2000). The National Quality Assurance and Accreditation Agency (NQAAA) process places on institutions the responsibility for developing both internal and external quality assurance systems. The agency is therefore working with the Supreme Council of Universities in Egypt to develop national reference standards for 19 sectors covering all higher education institutions, and worked on developing quality assurance and accreditation standards for various types of education, especially technical education through Technical Education Projects (NQAAC, 2007). Since 2005, HEIs have been under increasing pressure to become more accountable for the services they provide. Furthermore, technical education has had to face increased competition for resources depending on enhancement internal quality assurance system and linkage it with the industrial community. Until national reference standards are available, institutions should continue to find appropriate equivalent standards (NQAAC, 2004).

Mansoura University (MU)

Technical departments of higher education institutes within Mansoura University (MU) were selected as the setting for this study. First, it is necessary to define adequate levels of each of the various dimensions that constitute service quality in technical HEIs. Second, the NQAAA in Egypt process places on institutions the responsibility to develop internal quality assurance systems in various types of education, especially technical education through Technical Education Projects. Third, MU was founded in 1972, and from its inception, it kept all its traditional colleges.

Today, MU is considered one of the largest higher education institutes for education and research in Egypt. Nowadays, the university has 27 col-

leges. Its staff amounts to more than 5.527 full time equivalents with nearly 123,482 undergraduate students, and 6,238 postgraduate students. MU issued the first edition of "Knowledge Development" series entitled "A Guide of Technical Terms Used in the Quality and Academic Accreditation". This edition includes a good number of technical terms and expressions commonly used in the fields of quality and accreditation to define and simplify those concepts and expressions, to eliminate ambiguity and promote the use of these concepts to the teaching staff members, the co-members, the employees, and the students. Also, some universities such as Kafrelsheikh University (KU) follows the example of MU.

I see that, although NQAAC in Egypt have devoted a great deal of attention to the development of internal quality assurance systems in particular technical education, but there are still some unresolved issues that need to be addressed, and the most controversial one refers to the performance enhancement instrument. In MU, analysis of most of their audit reports show that the Technical Department is aware of the necessity of Quality Assurance.

A major problem is that the internal quality assurance system is not fully in place. In most of the audited Technical Departments, there are no systems in place for obtaining data that can be used to assess the quality of those departments. For instance, the audit report for TD explains that the University established a quality assurance unit, although it is noted that "quality assurance does not yet appear in the MU organizational structure". Also, the University does not seem to have recognized that "quality assurance requires the establishment of robust procedures and a cycle of monitoring feedback and actions that ensures development". The quality audit report of TD also states that although there are signs that the TD is committed to quality assurance, however "it has neither a written policy on quality assurance nor as of yet any designated committee with a specific and unique responsibility for this function". In general all the audit reports show that the institutions do not have a comprehensive and robust system for internal quality assurance that can be demonstrated as operating effectively and, consequently, it is very difficult for them to make any claims with regards to the quality of the education they are providing.

Literature Review

The issue of quality assurance (QA) in education has attracted a lot of attention from international institutions and initiatives with increasing

competition amongst higher education institutions (Sohail et al, 2003). Quality assurance is the process of verifying or determining whether services meet or exceed customer expectations. Quality assurance is a process-driven approach with specific steps to help define and attain goals and Quality Assurance in Higher Education has significantly influenced the process (both in external and internal aspects of quality assurance). So, this concept includes two processes; management and enhancement of quality. However, internal quality assurance systems, quality refers to the aptness of internal quality assurance based on goals and objectives. According to Hernes and Martin, (2008), the UNESCO, the Council of Europe, the Socrates Programme of the European Community, the OECD as well as the International Associations of Universities have published policy statements or recommendations related to this topic; as example the Socrates Programme, Quality Assurance Systems (QAS) in higher education consist of three levels. First level, at the international level (European dimension), it can mean promoting the development of quality assurance. Second level, at the National level (external quality assurance system), it can mean an external quality review process. In the external evaluation, this appraisal is subject to peer-review. Third level, at the institutional level (internal quality assurance system), it can be seen as an internal quality process that evaluates and assesses an institution or its programmes in relation to its aims and objective. The internal evaluation is a critical self-evaluation of the colleges and departments with respect to what is achieved; this is carried out in the form of an appraisal that considers self-determined goals (Moghadassian and Dosse, 2008). The University of Osijek developed an internal quality assurance model at the university to ensure standards of achievement, quality of teaching, and quality of management. This model depended on performance evaluation of internal quality assurance systems through three steps: defining quality, measuring quality, and improving quality (Ksenija, 2003).

One of the main concerns with NQAAC in Egypt, is the evaluation of the internal quality assurance system. The prime purpose of such a system is to maintain and improve the level of the educational programmes, the quality of the learning opportunities provided, and other elements affecting them. This system is responsible for the process of continuing quality improvement (NQAAC, 2007: 13). According to recommendations from the guideline of NQAAC based on the ISO quality management, the NQAAC set up "6 Golden

Rules" for developing a plan that will lead to the evaluation of internal quality assurance systems using the following steps: identify the goals, obtain information about current good practice in quality management, specify quality level and intended outcomes of educational programmes, determine the gaps between quality management system and current good practice in quality management, develop a plan to close the gaps and allocate resources to perform these action plans, and carrying out this plan to implement the identified actions (NQAAC, 2007).

During a seminar council in Europe (2008), standards and guidelines were put in place for the enhancement of internal quality assurance, its approval and review of programmes including internal evaluation of study programmes, review team involving staff and students, improvement measures and follow-up (Tück. 2008). But the Finnish Higher Education Evaluation Council FINHEEC (2006) saw that QA can be used in two ways; it may refer to the QA system of an individual HEI, or to the national system for assuring higher education quality. Therefore, quality can be defined in many ways, for instance, quality as exception, as perfection, as fitness for purpose, and as value for money.

FINHEEC displayed concern for enhancement-led evaluations; it refers to evaluations geared to support HEIs in improving their education and other activities. Evaluation is a systematic appraisal and highlights value or comparison against objectives, targets, and "measurement" of performance (assessment, as in quality assessment) against set criteria (Ilonen, 2006).

To understand quality assessment, there was an attempt to evaluate a particular service context and there were several methodologies. Within the last decade, the emergence of diverse instruments of measurement such as SERVQUAL, have been used for assessment of performance of service in the quality dimension and regression analysis was used to determine the relative impact of each service quality dimension on overall service quality. From this analysis the information can be used to focus on improving service quality features that have the most influence on overall service quality perception (Parasuraman et al, 1988). Cronin and Taylor, in 1994 suggested that survey results might be used to compare service quality performance across various units within an organization or across competitors in an industry (Cronin and Taylor, 1994). Hemmasi *et al.* (1994) propose that Performance-Importance Analysis be used to manage

service quality. It firstly involves measuring consumers' service quality performance perceptions and measuring consumers' perceptions of importance of each attribute; then, each service attribute would be plotted on a matrix in terms of its performance score and its importance score to highlight where improvement efforts should be focused (Hemmasi *et al.,* 1994). - Brown (1997) recommends firms employ a technique which compared service quality performance scores to a set of norms, when there is a tendency for others to outperform the organization under review (Brown, 1997). Barnett classified approaches to quality assessment; objectivist, relativist and developmental. According to the objectivist approach pass rates or learner drop-out rates are taken into account, but the relativist approach compares quality elements with those of residential universities, and the development approach is geared towards identifying problems in the programme and finding solutions for them. Hence, the relativist approach basically focuses on improving quality by comparison with each other, and it could be seen more as a means of quality assurance and accreditation than quality assessment (Nielsen, 1997: 289).

In view of that, Firdaus (2005, 2006) proposed HEdPERF (Higher Education PERFormance- only) a new and more comprehensive performance- based measuring scale that attempts to capture the authentic determinants of service quality within the higher education sector in Malaysian tertiary institutions (non-academic aspects, academic aspects, reputation, access, programme issues, understanding). But she modified the five - factor structure of HEdPERF as the most appropriate scale for higher education sector (dimension understanding dropped) (Firdaus, 2005, 2006). Sherein (2007) tested HEdPERF scale to determine which scale had the superior measuring capability in Egyptian higher education institutions through terms of uni-dimensionality, reliability, validity, and explained variance. An evidence of fair fit, it was concluded that the HEdPERF model fits fairly and represents a reasonably close approximation in the population. Also, the empirical analysis indicated that there was good internal consistency in all dimensions of the scale, the validity co-efficients for the scale are significant at $p = 0.01$ level, and it has a high ability in explaining the variance of service quality level. The current results also suggest that transforming it into an ideal measuring instrument of service quality for Egyptian higher education sector (Sherein, 2007).

Blose *et al.,* (2005) saw that, although some techniques generated in-

formation for shaping specific strategic efforts to enhance service quality and could be used to determine the relative impact of each service quality dimension on overall service quality, but the analysis would not specifically indicate how managerial and/ or organization behavior should be strategically modified, and how are resources to be devoted entirely to improving performance on the most influential dimension, and how much adjustment in resources should be made by shifting emphasis from relatively less important dimensions (Blose *et al.,* 2005). Another important problem associated with these techniques is that the basis used for judging service quality for other branches. So during the last few years, a national quality assessment system for evaluation of the core activities of universities has been established, the experiences of the new national quality assessments have been reported by Nilsson and Swahn (2001); Sjolund (2002); and Nilsson (2002). These reports were about universities' experience from the first years of participation in assessment activity. Swahn (2004) introduced a report about international benchmarking programmes managed by ESMU for driving the university's quality assurance a step further than is possible by means of national activities, this report concentrated upon role of international benchmarking in comparison with the established national quality assessment system (Swahn, 2004). Despite that, a number of methodological problems encountered during these activities from some difficulties in statistical comparisons which are considerably complicated by the basic concept definition. On the other hand, Davis (1998) proposed that particularly in the public sector, instead of benchmarking antique practices, it would be better to invent new ones (Davis, 1998).

Enhancement of Internal Quality Assurance Systems and DEA in HEIs

For previous reasons, all these approaches are somewhat problematic. In addition to that, it seems important to identify efficient levels of various dimensions of service quality that directly link to measures of specific institute outputs that do, intend to maximize, specially higher education institutions which need techniques used for identifying best practice by evaluating quality efficiency with the efficiency of quality among institutional units where there is a relatively homogeneous set of institutional units regardless to differences in organizational structure among branches, together with the growth in student numbers. In other words, higher education institutions required techniques which could be applied to all institutions that are similar in their characteristics across the country regardless of their different natures and systems.

The Data Envelopment Analysis (DEA) - model is able to contain incomplete data. The technique has many unique characteristics that make it used in many applications. Such techniques are its ability to determine the following; the best practice-most productive group of DMUs, the inefficient- less productive DMUs compared to the best practice DMUs, the amount of excess resources used by each of the inefficient DMUs, the amount of excess capacity or ability to increase outputs present in inefficient DMUs without utilizing added resources, and the best practice DMUs that most clearly indicate that excess resources are being used by the inefficient DMU (Sherman,1992).

In the education domain, DEA has been widely used, Athanassopoulos and Shale (1997) examined the comparative of higher education institutions in the UK and used DEA to assess the two types of efficiency. The application of this methodology showed satisfactory performance across alternative efficiency tests. Soteriou *et al.* (1998) utilized the methodology of DEA to assess the efficiency of secondary schools in Cyprus, and evaluated the relative efficiency of schools to providing recommendations for improvement to inefficient schools. Abbott and Doucouliagos (2003) used DEA to estimate technical and scale efficiency of individual Australian universities through various measures of output and inputs. Johnes *et al.* (2009) applied DEA to assess the cost structure and the performance of various groups at educational institutions in England.

On the other hand, Debnath and Shankar, (2009) stressed on the performance measurement of management institutes which have received very little attention compared with other industries due to the difficulty of measuring its output. Accordingly, they tried to examine the performance of 20 Indian management schools. The DEA technique allowed the identification of institutions which were able to utilize their resources in a more efficient way such that the overall goals of the organization are satisfied and total outcome maximized. Also, Kantabutra (2010) employed DEA to measure public upper schools in Thailand. The results revealed that most schools operate inefficiently, and a policy to improve school efficiency may thus consider using efficiency-based analysis for measuring school performance to identify which school will yield higher marginal returns to prioritize inefficient schools for treatment.

In the higher education context, the application of DEA has focused on various issues, such as the efficiency of academic departments (Johnes and Johnes, 1993; Tomkins and Green,

1988), universities (Avkiran, 2001; Ahn *et al*., 1988; Antonio and Mariana, 2008; Coelli,1969), ACADEMIC RESEARCH (Korhonen, 2001), university libraries (Chen, 1997), central administrative services in universities (Casu and Thanassoulis, 2006), technical institutions (Khan *et al.,* 2008), quality control in distant education (Ibara, 2008), evaluation of efficiency, technology and productivity among universities (Aracil and Montero, 2008), performance of higher education institutions (Joumady and Ric, 2009), and teaching and course evaluation (Sarkis and Seol, 2010).

I see that a new analytical technique, DEA seems appropriate for the enhancement of internal quality assurance systems within HEIs (defined as being faculty or college), this is because amongst other characteristics:

1) DEA used in comparing the efficiency of units homogeneous with a set of departmental units. This principle alone takes it as judgment not isolated but always in relation to relevant alternatives,
2) DEA can provide quantitative measurement for one unit's efficiency relative to all other units, and to other similar units; identify the sources of inefficiency; identify best-practice departments; and provide quality performance-benchmarking national indicators,
3) DEA can determine the degree of (in) efficiency of a unit by measuring its distance to the efficient frontier which is made up of all identified "efficient" units. They all demand the lowest inputs for a given bundle of characteristics, at different scale levels and create a maximum performance of internal quality assurance systems. These so called efficient peers represent benchmarks for all inefficient peers,
4) Furthermore, all units whose efficiency is estimated via the same benchmark(s) have a comparable input - output - structure; otherwise different benchmarks would be identified as reference groups,
5) DEA has the ability to handle multiple inputs and outputs simultaneously, this is important for non-profit making organizations such as educational departments whose operations are characterized by multiple inputs and outputs and,
6) DEA applies the same vector of parameter weights to all units exogenously would essentially apply one and the national benchmark to all units.

Objective of the Study

Quality in higher education plays a key role to gain best performance; efficiency of an institution must relate

its performance with internal quality assurance systems. As quality in higher education characterizes multi-input and output systems, its measurement through the efficiency score enables the provision of an accumulation of performance based on quality. The relative efficiency score of departments enables ranking and the inefficient departments can track continuous improvement strategies by adjusting the slack and target values. Therefore, the objective of this study focuses on proposing Data Envelopment Analysis (DEA) such as managerial approach which aids in performance enhancement of internal quality assurance systems in technical departments within Mansoura University, by ranking technical departments based on their efficiency scores, and defining enhancement areas for the inefficient departments.

Methodology

The methodology for enhancement of internal quality assurance systems in technical departments is illustrated in figure 1.

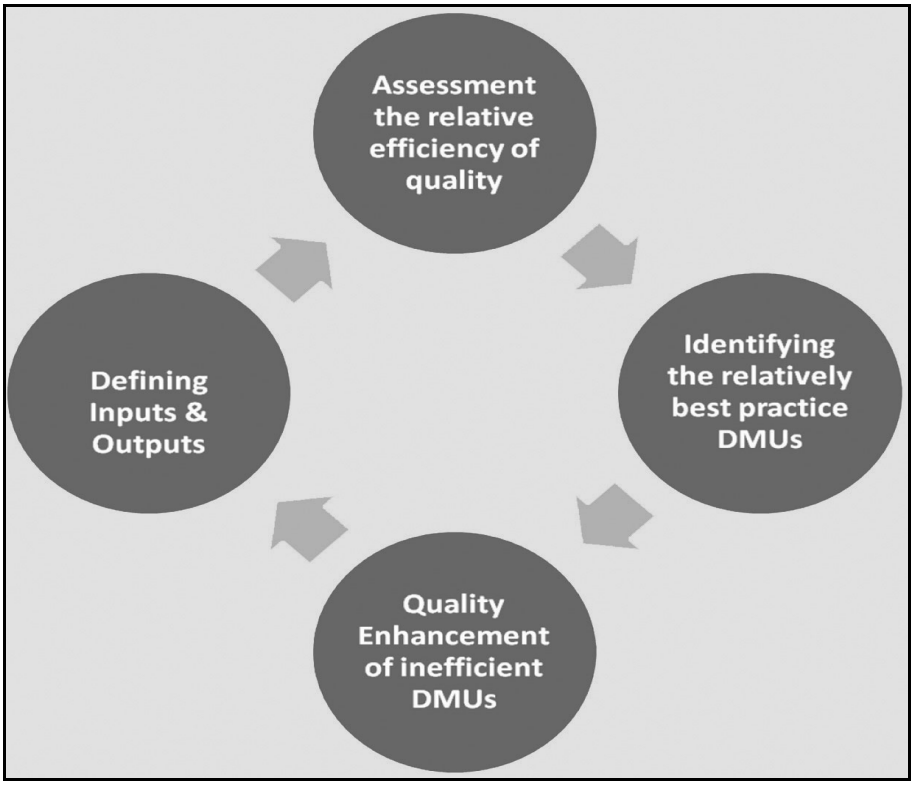

Figure 1: Framework for Enhancement of Internal Quality Assurance Systems

As we see from the previous figure, DEA enhances the internal quality assurance systems through four steps: [1] Defining Inputs & Outputs, [2] Assessment of the relative efficiency of quality of each department's DMUs, [3] Identification of the relatively best practice departments (DMUs) to define an efficient frontier, and [4] Measurement of the degree of inefficiency of the other departments relative to this frontier to enhance the quality of inefficient departments (DMUs).

A. Overview of the DEA approach:

DEA is a technique developed by Charnes, Cooper and Rhodes in 1978 to assess the relative efficiency of non-profit and public service organizations for monitoring organizational performance. DEA compares the elements of outputs and inputs for all units of an organization, identifies the relatively best practice units which define an efficient frontier, then measures the degree of inefficiency of the other units relative to this frontier. In other words, DEA uses a linear programming approach to measure the potential of input reduction at a unit, given its output levels, or the potential for output augmentation given its input levels (Charnes *et al., 1978)*.

1. Charnes-Cooper-Rhodes -Model

There have been a large number of studies conducted which have applied the methodology of Charnes, Cooper and Rhodes (CCR) in 1978, so the basic model DEA is known as the CCR model. During the last few years, a number of enhancements to the basic DEA models have been presented in the literature Charnes *et al.*, 1994, which determines efficiency scores by the quotient of the weighted sums of outputs and inputs, thus efficiency scores, detailing the portion of inputs the DMU is allowed to use to create the current amount of outputs (in the input-oriented model), or vice versa (output-oriented), are conceived (Charnes *et al.*, 1994).

The efficient DMUs, with a score of 1, and their linear combinations form an efficiency frontier, against which the inefficient DMUs are compared (Cooper *et al.*, 2007). Two keys characteristic of the DEA instrument are that the weights and the efficiency frontier, which defined empirically from the data set. This is one of the distinguishing qualities of the method, which has important implications, for example in the case of composite indicator 30 calculations (Cherchye *et al.*, 2007). Mathematically represented, DEA maximizes the ratio of output to input. So, a new managerial technique, DEA, became a methodol-

ogy widely employed in evaluating relative efficiency.

The CCR-model is sometimes referred to as the CRS-model, due to the fact that it builds on the assumption of Constant Returns to Scale (CRS). Constant Returns to Scale means that outputs increase in direct relation to an increase in the inputs, or similarly decreases in inputs bring about relative decreases in outputs. The function of the CCR-model, seeking to maximize outputs, is the following (Osasto, 2007):

$$\text{Maximise } \theta = \sum_{r=1}^{s} \mu_r y_{ro}$$

$$\text{subject to } \sum_{i=1}^{m} v_i x_{io} = 1$$

$$\sum_{r=1}^{s} \mu_s y_{sj} - \sum_{i=1}^{m} v_m x_{mj} \leq 0$$

$$(j = 1, ..., n)$$

$$v_1, v_2, ..., v_m \geq 0$$

$$\mu_1, \mu_2, ..., \mu_s \geq 0$$

Where

θ = sum of virtual outputs

x_j = amount of input i used by DMU j

y_{ri} = amount of output r produced by DMU j

v_i = weight of input i

μ_r = weight of output r

n = number of DMUs

Subscript o refers to the DMU whose efficiency is calculated.

The model is solved (n) times to determine the relative efficiency for each DMU. The model represented here is the most basic DEA-model. Subsequent models and elaborations have brought in additional features, such as the calculation of slacks to determine the adjustments by which an inefficient unit could achieve efficient status; multi-stage calculation of DEA also allows the definition of peers, where 31 are a reference set of DMUs with a similar mix of inputs and outputs (Coelli, 2007). Main goal of the program is to maximize each department's efficiency score, if this were the only constraint, the set of weights selected for each department would be the set that gives each department an efficiency score of one. This ratio of the weighted outputs and inputs is maximized under the restriction that no other department attains a score greater than 1 with the same weights that maximize the Efficiency of Service Quality (ESQ) of the department that is being evaluated. Thus, all departments with an ESQ of 1 offer a maximum relative efficiency of service quality in the context of the institutions departments under investigation. Since all departments whose efficiency is estimated via the same benchmark(s) must have a comparable input-output structure; otherwise deferent benchmarks would be identified as reference points. So the

degree of inefficiency of a department is determined by measuring its distance to the origin relative to that of an efficient benchmark (see, Coelli, 2007; Osasto, 2007; Cherchye *et al*, 2007; Cooper *et al*, 2007).

2. Barney-Charnes-Cooper -Model

The Constant Return to Scale assumption is of course not valid in all situations, the basic CCR-model was proposed by Banker, Charnes and Cooper in 1984. The model has been named the BCC-model after its creators (or sometimes alternatively, the variable returns to scale VRS model) and widely accepted as the basic DEA model for cases with VRS. Mathematically, the BCC linear programming model may be represented as follows (Bowlin, 1998):

$$\text{maximize: } \sum_{r=1}^{s} u_r y_{ro} - u_o$$

$$\text{subject to: } \sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} - u_o \leq 0$$

$$\sum_{i=1}^{m} v_i x_{io} = 1$$

$$-u_r \leq -\varepsilon$$

$$-v_i \leq -\varepsilon$$

The VRS quality of the model makes it more flexible and less strict than the previous CCR-model. As a rule, CCR-efficiency scores never exceed BCC-scores, although the opposite often is true (see, Bowlin, 1998; Charnes and Cooper, 1984).

3. Recent Developments

DEA is a relatively new method of analysis, and as such it is still constantly evolving. In addition to the two basic models presented above, several other variations exist, such as the additive, slacks based measurement and hybrid models, just to name a few. There are also extensions and ways to modify the models to better adapt them to different scenarios. Although the free distribution of weights empirically is one of the main properties of DEA, the weights may also be manually constrained to prevent manifesting of false efficiency through untruthful input and output profiles. Also, the efficiency scores themselves may be modified by extending the model to take into account what is known as super-efficiency, this is a way of determining 'the best of the best' in a group of peers. These are only some examples of extensions that have been made to the DEA method recently (see, Cooper, 2007; Osasto, 2007).

B. Construction of the DEA-Model

DEA mathematically determines the best weights for each input and output for the particular DMU under analysis so as to maximize the relative efficiency ratio while satisfying certain minimal conditions specified in the model (Sexton, 1986). Here it deter-

mines the degree of (in) efficiency of service quality for a department by measuring its distance to the efficient frontier. The efficient frontier (best practice line) is made up of all identified "efficient" departments. They all demand the lowest inputs for a given bundle of characteristics, at different scale levels and create a maximum service quality. These so called efficient peers represent benchmarks for all inefficient units. This principle adequately adopts for the enhancement of internal quality assurance systems in the sense that the quality efficiency of department that is judged not isolated but always in relation with relevant alternatives. The comparison against the efficient frontier is to define the sources of its inefficiency. To make relatively inefficient departments, the proper input and output weights can be chosen in such a way that the distance between each department and efficient frontier is minimized. For more details on the concepts of DEA, see Boussofiane, 1995; Norman *et al*, 2003.

1. Identifying input-output variables

Figure 2 illustrates the conceptual framework in which input and output variables relating to the provision of departments within HEIs are going to be investigated. The inputs and outputs listed in figure 2 were selected from indicators of evaluation and accreditation which set as guidelines and templates for the self-study that were prepared by NQAAC for higher education in Egypt (NQAAC, 2007):

1.1 Inputs

1.1.1 Student Support

It means both academic and non-academic services provided to student. It includes:

- Identifying the non-academic needs of a student,
- The model of support adopted to meet those needs,
- Suitability of support services provision,
- The management and staffing of support services and,
- Delivering of services throughout the student's career.

1.1.2 Teaching and Learning Methods

These are the methods which are used by teachers to help students achieve the ILOs for the course. It includes identifying the methods used in the course such as:

- Lectures,
- Discussion sessions,
- Information collection from different sources,
- Practical,
- Field visits,
- Case studies, etc.

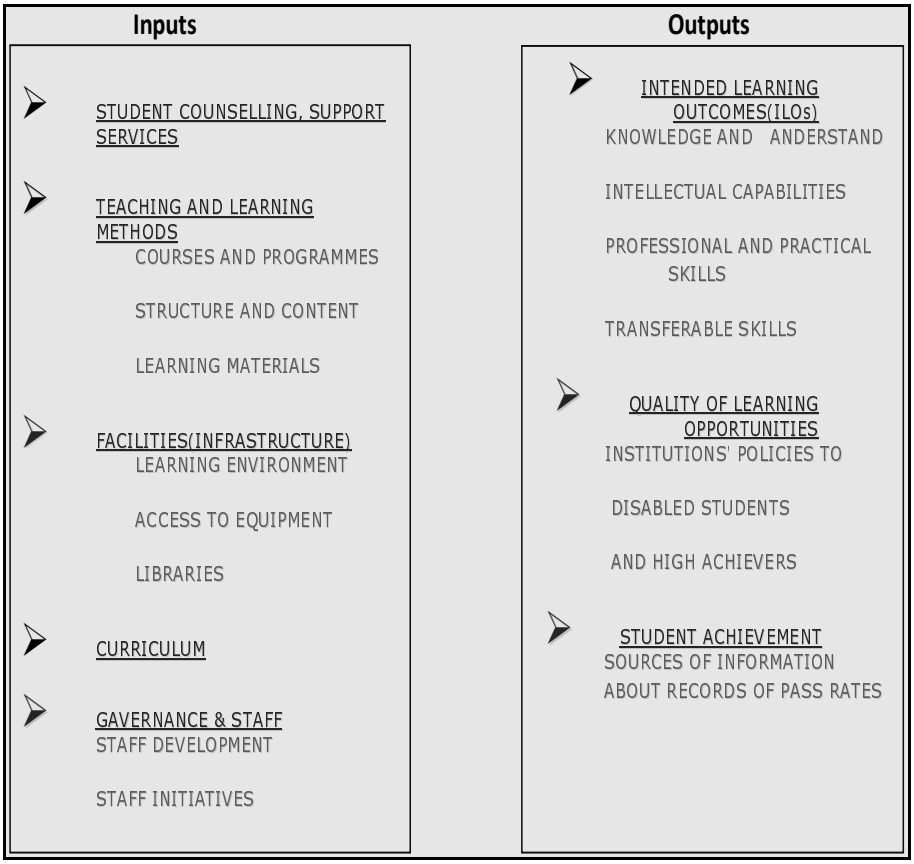

Figure 2. The Conceptual Inputs and Outputs Framework

1.1.3 Facilities required for teaching and learning

The facilities include, appropriate teaching accommodation, including teaching aids, laboratories equipment, computers, facilities for field work, site visits etc, which are necessary for teaching.

- Availability and adequacy of programme handbook.
- Adequacy of library facilities.
- Adequacy of computer facilities.
- Adequacy of field/ practical training resources.
- Adequacy of any other programme needs.

1.1.4 Curriculum

The curriculum for the programme facilitates the attainment of the stated intended learning outcomes

- Curriculum design, evaluation and monitoring,
- Curriculum structure,
- Breadth, depth,
- How current curriculum content is

1.1.5 Governance, Administration & Staff Development

It includes a selection of academic leadership, effectiveness of policies, systems and practices, responsiveness to changing priorities and emerging needs, enhancement activities to the strategic objectives and plans, review of staff development.

- Mission and strategy development, planning, policy and leadership.
- Attracting and retaining staff.
- Staff are competent to teach, facilitate learning and maintain scholarly approach.
- Training and developing staff.
- Encouraging initiative and assessing performance.
- Staff feedback and monitoring.
- Appropriate teaching accommodation.
- Developing and integrating human resource policies.

1.2 Outputs

1.2.1 Intended Learning Outcomes (ILOs)

- Knowledge and comprehension,
- Intellectual capabilities,
- Professional and practical skills,
- General and transferable skills.

1.2.2 Quality of learning opportunities in educational programmes

- Students' participate in all aspects of academic life,
- Students' opinions on quality of teaching and learning,
- Institutions' policies for the quality of learning opportunities to disabled students and high achievers.

1.2.3 Student Achievement

This means evaluation of student achievement of appropriate standards.

- Records of pass rates and samples of student work,
- Reviews of students' activities with academic staff,
- Evaluation of stakeholders (employers) to alumni.

In this context, the input variables should capture all resources used by, and the output variables are all the outcomes related to the institute. In sum, I opted to use the inputs and outputs variable in table 1 to which I refer to as my basic model.

2. Selection of DMUs

In order to identify DMUs, 10 technical departments within Mansoura University offering technical education in both the College of Engineering and College of Computer

Table 1
Input and output variable (basic model)

Inputs:

1 - Student Support.
2 - Teaching and Learning Methods.
3 - Facilities required for teaching and learning.
4 - Curriculum.
5 - Governance, Administration & Staff Development.

Outputs:

1 - Intended Learning Outcomes (ILOs).
2 - Quality of learning opportunities.
3 - Student Achievement.

(Adapted from NQAAC, 2007)

and Information Science in undergraduate, postgraduate and research level have been considered. They offer undergraduate degrees (Bachelor of Science), postgraduate degrees (Diploma, Master of Science, and Doctorate). The list of DMUs is shown in Table 2.

C. Questionnaire Survey

A sample of technical departments within Mansoura University were surveyed over a three- month period during the academic year 2008/2009. The data used was made available to me through a final questionnaire, adding to Quality Assurance Units (QAUs), annual overview reports on quality of educational activities, and records of pass rates, etc,. In brief, the method of preparing the final questionnaire was according to Casu and Shaw (2005), and assessment follows:

- Following the receipt of primary questionnaires, each participating unit submits a general contextual self- description together with a report on each of the inputs and outputs area,
- The primary questionnaire and all reports are discussed at a joint seminar for two participating units,
- At this seminar, unit representatives also conduct a short presentation of various activities within the assess-

Table 2
Technical Departments in Mansoura University (DMUs)

Symbol	Institute	Name of the Departments (DUMs)
DMU1	Faculty of CIS	Computer Science
DMU2	Faculty of Eng.	Electronics& Communications Eng.
DMU3	Faculty of CIS	Information Systems
DMU4	Faculty of Eng.	Architectural Eng.
DMU5	Faculty of Eng.	Structure Eng.
DMU6	Faculty of Eng.	Textile Eng.
DMU7	Faculty of Eng.	Production Eng.& Mechanical Design
DMU8	Faculty of Eng.	Power& Electric Machines Eng.
DMU9	Faculty of Eng.	Computer Eng.& Systems
DMU10	Faculty of Eng.	Mechanical Eng.

ment areas. The topics of these presentations are dependant on the basis of departmental reports,

- After this seminar, the questionnaire is completed with two participating units in the different areas.

The areas of assessment list above are divided into sub- areas such as inputs and outputs. I formulated a number of detailed questions, illustrating central aspects of the sub- area. Many of the detailed questions are inspired by the methods and questions prepared by NQAAA (2007). The questions are answered in a questionnaire, the departments' reports are used to formulate a comprehensive statement of collected excess data about departments' practices within an assessment area, and the questions are answered by responsible persons. Every department's own report and analysis as an answer to questionnaire from a solid basis for validation. The responses of students about their perceptions and expectations under each item are collected through a structured questionnaire survey. Each respondent is asked to rate his/ her opinion on a Likert type scale of 1 to 5 (1 being strongly disagree and 5 being strongly agree). A large number of items offered tend to displace the average score on that sub- area towards the middle of the 1 to 5 scale. The survey is administered to the respondents via personal contacts. Further, additional data is collected from experts such as the heads of institutions and heads of departments through personal contacts. Finally, 513 responses were taken into consideration for further analysis after

screening the responses and measuring rationality in judgmental scores.

DEA Application

A. Model Assumptions

Two assumptions must be made to use the basic data envelopment analysis model in the form presented previously; these are outlined by Nunamaker (1983) as follows; first, the DEA approach assumes constant returns to scale for each DMU evaluated. Second, it is assumed the constructed efficient production frontier is piece- wise linear and continuous. More importantly, this second assumption implies that all points along the efficient surface are practically attainable production possibilities (Nunamarker, 1983).

The objective function for the DEA has been fixed as the ratio of the weighted sum of perceptions to the weighted sum of expectations assuming that perception of a student rarely affects the expectation. Hence, a DMU becomes a best unit when the objective function becomes uniform which means perceptions is equal to expectations. If either of these assumptions has not been achieved, there are other modified versions which must be applied. The general output oriented maximization CCR-DEA model is used to obtain efficiency score. Data Envelopment Analysis Programme (DEAP version 2.1) has been used to solve the model.

B. DEA Relative Efficiency Scores

To illustrate the use of new managerial instrument (DEA), the inputs were calculated by first averaging the responses for each item across all the surveys obtained for a particular department. For example, Table 3 lists

Table 3
Quality Item Level Summary for Department 1 (Survey Item Number)

Dimension	Item	Item	Item	Item	Item	Item	Item	Item	Row average
1	5.46	5.48	5.59	5.02	5.10				5.33
2	5.53	5.46	5.16	5.31					5.37
3	5.10	5.10	5.24	5.14	5.32	5.23	4.66	4.92	5.09
4	5.50	5.34	5.45	4.31	4.20	4.00	5.23		4.86
5	5.57	5.54	4.96	5.43	5.47	5.37	5.00		5.33

Keys:
1 = Student Support.
2 = Teaching and Learning Methods.
3 = Facilities required for teaching and learning.
4 = Curriculum.
5 = Governance, Administration & Staff Development.

the average values of the data analysis for each item for department 1. Then, to create five dimensional - level scores for each department, these item level averages were averaged within their corresponding dimension. The last column of Table 3 shows these values for department 1.

Table 4 shows the resulting dimension - level summary measures for all of the departments included this study. Table 5 listed the resulting efficiency scores for each department from resulting DEA score for each DMU

Table 5 indicates the efficiency score for departments, ranging from 0.911 to 1.000. Three departments were assigned an efficiency score of 1.00. In the context of this article, these units would be said to be obtaining relatively, the best quality of learning opportunities, Intended Learning Outcomes (ILOs), and Student Achievement, given each DMU's level on the five dimensions of service quality performance. But those initiatives operating less than perfectly efficiently, have to enhance. So, they might turn to the results of the dual problem from the DEA for guidance as to how they might enhance the efficiency.

From Table 5 and Table 6, DMU7 should examine it operating procedures in these identified service quality

Table 4
Dimension- Level Input Data & Output Data for All Departments

Departments	1	2	3	4	5	OSQ	QLO	ILOs	SA
DUM1	5.33	5.37	5.09	4.86	5.33	2.86	3.01	10.89	2.26
DUM2	3.70	4.54	4.23	4.86	4.84	3.88	2.66	10.98	3.84
DUM3	5.92	5.47	5.61	5.42	5.11	2.62	2.49	5.93	3.03
DUM4	5.84	5.91	5.63	5.63	5.30	2.58	2.89	5.87	2.82
DUM 5	5.03	5.22	5.05	5.00	5.10	2.99	3.18	10.96	2.36
DUM 6	5.51	5.99	5.87	5.32	5.52	2.11	2.07	2.16	2.17
DUM 7	5.96	5.98	5.83	5.98	5.52	2.10	2.08	3.27	2.18
DUM 8	5.76	5.62	5.21	5.33	5.50	2.63	2.96	7.88	2.67
DUM 9	5.53	5.76	5.32	5.13	5.43	2.62	2.84	5.87	2.68
DUM 10	5.11	5.15	5.72	5.22	5.40	2.51	2.89	5.87	2.53

Keys:
OSQ = Overall service quality (dependent variable of regression)
QLO = Quality of learning opportunities
ILOs = Intended Learning Outcomes (ILOs).
SA = Student Achievement.

Table 5
DEA Relative Efficiency Scores

Departments	Efficiency score
DMU2	1.000
DMU5	1.000
DMU1	1.000
DMU8	0.995
DMU10	0.990
DMU9	0.977
DMU3	0.933
DMU4	0.923
DMU6	0.921
DMU7	0.911

performance dimensional areas comparing with DMU2 to identify possible sources of inefficiency and accordingly enhance them.

C. Defining Enhancement Areas for Inefficient Departments

The guidance described earlier in the form of a hypothetical, relatively perfect efficient DMU whose input levels can be used in existing inputs or outputs that would help the DMU move towards the efficiency current input and output levels and the enhancement that the analysis identified for DMU7.

From Table 6, DMU7 should examine its operating procedures in these identified service quality performance dimensional areas to identify possible sources of inefficiency. The analysis suggests that, the greatest efficiency for DMU7 gains are possible in the area of Student Support, and Facilities required for teaching and learning, Teaching and Learning Methods, and Curriculum dimensions of its service quality performance offering.

Results and Discussion

In the higher education context, it is not easy to measure the output of the services, especially when an institute has multiple inputs and outputs. In this case a possible method of determining efficiency is Data Envelopment Analysis. Using DEA as a classification and ranking tool is lacking and as a consequence, I do not see DEA used for these purposes as much as it should be.

This study introduces DEA as a managerial tool for evaluating and

Table 6
DEA Efficient Reference Set Weights

DMUs	Weights to apply to the DMUs in the efficient reference sets		
	DMU2	DMU5	DMU1
DMU1			1.0000
DMU2	1.0000		
DMU3		.5123	.4536
DMU4	.3427	.6234	
DMU5		1.0000	
DMU6		.6088	.3256
DMU7	.3452	.3425	
DMU8		.4356	.6834
DMU9		.3452	.5437
DMU10		.6321	.3245

Table 7
Current and Prescribed Input & Output Levels for DMU10

DMU	1*	2*	3*	4*	5*	QLO	ILOs	SA
DMU7	5.96	5.98	5.83	5.98	5.52	2.08	3.27	2.18
Target level (DMU2)	3.70	4.54	4.23	4.86	4.84	2.66	10.98	3.84
Enhance-ment level	-2.26	-1.44	-1.60	-1.12	-0.68	0.58	7.71	1.66

* (1 = Student Support, 2 = Teaching and Learning Methods, 3 = Facilities required for teaching and learning, 4 = Curriculum, 5 = Administration & Staff Development).

enhancing service quality. This new approach treats service quality as a mediator variable, and using a non-parametric technique, DEA for the relative comparison of a number of comparable organizational decision-making units.

In my paper I would like to introduce this managerial technique and use it to compare the efficiency of technical departments in MU. This approach was followed to study a respected and accepted classification system and establish connections with DEA techniques for enhancement of Internal Quality Assurance System in HEIs. An important conclusion is that a critical aspect in selection of inputs & outputs, is the model. The price paid is

greater conceptually and in computational complexity. Furthermore, I am examining the enhancement areas for inefficient departments.

However, it is easy to observe from Table 5 that the most efficient departments with the standard approach, are the Electronics & Communications Engineering, Structure Engineering, and Computer Science. Production Engineering & Mechanical Design, Production Engineering & Mechanical Design, and Architectural Engineering are located on the opposite end of the rank. Production Engineering is ranked at 10. If this department wants to become efficient, it will have to aim to the position of Electronics & Communications Engineering, - as peers to identify possible sources of inefficiency and enhance them.

In order to define enhancement areas for inefficient departments, I created a model which contains all the explanatory variables. Table 4 provides information on the dimension - level input and output for all departments. Table 7 provides information on the dimension - level input and output for Production Engineering & Mechanical Design that would help it to move towards Electronics & Communications Engineering which has the efficiency input and output levels. Production Engineering & Mechanical Design can access it through enhancement of Student Support, and Facilities required for teaching and learning, Teaching and Learning Methods, and Curriculum dimensions of its service quality performance offering.

Conclusion

The purpose of this study was to propose a new managerial instrument for performance enhancement of internal quality assurance systems, and employ the DEA approach to estimate efficiency scores for technical departments within Mansoura University (MU). The evidence suggests that frontier analysis was able to separate departments that might qualify, as performing well from those where some enhancement might be possible, and a new managerial instrument (DEA) encouraged institutions to compare their departments' quality performance with equivalent standards, and could treat quality as the relative comparison of a number of comparable departmental decision-making units (DMUs). The basic contribution of this instrument, the DEA technique, can help institutions obtain optimal levels of quality dimensions that are directly linked to critical performance outcomes. This could imply a better allocation by the departments of the usually scarce public financial resources available to higher education institutions and performance enhancement of internal quality assurance systems.

Limitations and Suggestions for Future Research

The current study allows us to understand how DEA instrument measures internal quality insurance systems in comparison to others. However, this work poses more questions than it provides answers. The present findings suggest that the DEA instrument is appropriate in higher education service setting. Given that the current study is limited to one service industry, this assertion would need to be validated by further research. Future studies should apply the measurement instrument to help the Egyptian National Quality Assurance and Accreditation Agency (NQAAA) attain national academic reference standards directly linked to critical performance outcomes for Egyptian HEIs through measuring performance of quality for an institute relative to all other similar institutions and identifying best practice to compare academic standards of an institute with equivalent standards nationally, then identifying sources of quality inefficiency. In other words the DEA technique can provide NQAAA with national quality benchmarking indicators

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الملخص

الجودة في التعليم العالي المصري: استخدام أسلوب تحليل البيانات المتداخلة لتحسين أنظمة ضمان الجودة الداخلية في أقسام التعليم الفني

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هذا البحث يضع الخطوط العريضة لنتائج دراسة تستهدف اقتراح أداة إدارية جديدة لتحسين أداء أنظمة ضمان الجودة الداخلية بالتعليم الفني، وتوظيف تحليل البيانات المتداخلة لتقدير مستويات الكفاءة لأقسام كليات الهندسة والحاسبات. وقد تم قياس المدخلات من خلال عدة متغيرات متمثلة في خدمات الدعما لطلابي، وأساليب التعليم والتعلم، والتسهيلات والموارد والإمكانات، والمناهج الدراسية، والإدارة، وتطوير أعضاء هيئة التدريس والعاملين. في حين تم قياس المخرجات من خلال متغيرات نتائج التعلم المستهدفة، وجودة فرص التعلم، وإنجاز الطلاب. وقد استخدم تحليل حد الكفاءة للتوصل إلى الأقسام الفنية المؤهلة لتقديم أفضل أداء، ومن خلال المقارنات النسبية بين الأقسام الأخرى وحد الكفاءة تم تحديد الأقسام الفنية التي تحتاج إلى تحسين، وكذلك مقدار التحسين الخاص بكل عنصر من عناصر المدخلات والمخرجات. واكدت النتائج أن الأداة الإدارية الجديدة يمكنها أن تساعد في تحسين الجودة من خلال القيام بالمقارنة النسبية لعدد من الأقسام المتشابهة في الخصائص والقابلة لإجراء المقارنات. وتوصلت نتائج البحث إلى أن أسلوب تحليل البيانات المتداخلة استطاع أن يحدد المستويات المثلى لأبعاد الجودة، والتي ترتبط مباشرة بمخرجات الأقسام الفنية، وهو ما يمكن أن يساعد في التخصص الأمثل لموارد الجامعة، كما يساعد في تعزيز أنظمة ضمان الجودة الداخلية بالكليات.

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مجلة دراسات الخليج والجزيرة العربية

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صدر العدد الأول منها في يناير عام 1975م

ترحب المجلة بنشر البحوث والدراسات العلمية المتعلقة بشؤون منطقة الخليج والجزيرة العربية في مختلف علوم البحث والدراسة .

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- ملخصات الرسائل الجامعية: ماجستير - دكتوراه.
- التقارير : مؤتمرات - ندوات

الاشتراكات

ترسل قيمة الاشتراك مقدماً بشيك لأمر - جامعة الكويت
مسحوب على أحد المصارف الكويتية

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الدول العربية : للأفراد : 4 دنانير - للمؤسسات : 15 ديناراً
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