Measuring the Efficiency of Quality Management Practices in Turkish Universities

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Abstract: Using data envelopment analysis (DEA) this study attempts to measure the relative efficiency of Turkish universities with regard to the implementation of quality management practices. A set of 9 critical quality management factors for Turkish universities are identified and used as input parameters for the efficiency model. In addition, a number of performance indicators are determined as the outputs which can be explained by the input parameters. Relying on a survey questionnaire, primary data was collected from a sample of 20 universities located in Istanbul, Turkey. Empirical analysis also focuses on the relative efficiencies of the universities based on their ownership pattern in the implementation of quality management practices.

Keywords: Total quality management, service operations management, data envelopment analysis, higher education.

I. Introduction

Using data envelopment analysis (DEA), the study essentially focuses on measuring the relative efficiency of Turkish universities. DEA is based on a linear programming technique for measuring the relative efficiency of organizational units. Although this technique has received significant attention in recent years due to its advantages over traditional methods and has been immensely applied in various problem settings, only very few studies have investigated its applicability in measuring the efficiency of higher education institutes (HEIs) (Kao and Hung, 2008). It is therefore worthwhile to extend the traditional DEA approach into the higher education research. While standard DEA model is assumed to have multiple incompatible input and output variables that are of quantitative nature, it can also be applied to a number of wide ranging problem settings where qualitative data have been heavily used, including not-for-profit organizations and service firms. In line with previous literature, this study essentially applies DEA methodology relying on qualitative survey data obtained from HEI environment.

II. Literature Review

Implementation of quality management (QM) is the culture of an organization committed to customer satisfaction through continuous improvement. This culture varies from one country to another and between different industries, but has certain essential principles, which can be implemented to secure greater market share, increased profits, and reduced costs (Kanji and Wallace, 2000). Management awareness of the importance of QM practices, alongside business process reengineering and other continuous improvement techniques was stimulated by the benchmarking movement to seek, study, implement and improve on best practices (Zairi and Ahmed, 1999). A review of extant literature on QM and continuous improvement programs identifies a set of common aspects: committed leadership, adoption and communication of QM, closer customer relationships, benchmarking, increased training, open organization, employee empowerment, zero defects mentality, flexible manufacturing, process improvement and measurement (see Black and Porter, 1996; Saraph et al., 1989; Flynn et al., 1994; Anderson et al., 1994; Ahire et al., 1996; Zhang et al., 2000; Demirbag et al., 2006).

While QM has long been used in the manufacturing area, its application in services is relatively new. Implementation of QM principles is also applicable to higher education (Owlia and Aspinwall, 1997). As a standalone process, QM has the potential of improving quality in educational institutions and achieves continuous improvement (Kanji et al., 1999). The initial attempts to implement QM in US higher education institutions (HEIs) date back to early 1980s (Kanji et al., 1999). In the UK, the first QM initiatives in HEIs were experienced in the late 1980s and early 1990s (Kanji and Malek, 1999). In contrast to the US, the impetus to introduce QM in the UK stemmed from the government (Owlia and Aspinwall, 1997). A 1998 survey on HEIs in the UK indicated that the UK HEIs were hardly involved in QM and had a lack of interest in adopting it in the future (Kanji and Malek, 1999).

Vazzana et al. (2000) identify three main areas to implement QM in higher education: Curriculum, non-academic functions and academic administration. Even though a relatively high use of QM was reported by administrative, support and academic departments, only a small number of institutions employed a complete QM model (Vazzana et al., 1997, 2000). Koch and Fisher (1998) also express that QM is only marginally useful in the rapidly changing environment that HEIs inhabit today. In their empirical

study, Elmuti et al. (1996) assessed the status of QM practices in HEIs in the US. Almost one third of respondents failed to achieve their targets on improving quality of teaching and research. Major reasons for failure were due to implementation of QM programs without a full grasp of their nature, tenure system in the US and autonomous role of the professors in academia. In the implementation of QM in HEIs, there are number of difficulties such as preparation of curriculum, teaching continuous improvement process and increasing research activities (Mergen et al., 2000). The other barriers for QM in HEIs are lack of agreement on the meaning of quality and academic freedom, unwillingness to change, compartmentalization, and lack of competition and conformance to minimum requirements (Owlia and Aspinwall, 1997).

The scales adopted in this study for HEIs are largely adaptation of the relevant constructs initially developed for manufacturing companies (Black and Porter, 1996; Saraph et al., 1989; Flynn et al., 1994; Anderson et al., 1994; Ahire et al., 1996; Zhang et al., 2000; Demirbag et al., 2006). Owlia and Aspinwall (1997) also express that the type of activities carried out on manufacturing is not so different from those on HEIs, and suggest a checklist with 10 factors for QM implementation on HEIs. Tang et al. (1998) apply 5 factors to benchmark higher education with financial services. Kanji et al. (1999), and Kanji and Malek (1999) identify 9 critical success factors to compare the state of arts of QM implementations in the UK, the US and Malaysia. QM implementation scales considered in this study are as follows: Leadership, vision, measurement and evaluation, process control and improvement, program design, quality system improvement, employee involvement, recognition and reward, education and training, student focus, and other stakeholders focus. The detailed discussion of these scales and their development procedure are provided in Bayraktar et al. (2008).

III. Research Methods

Sample

A questionnaire for this survey was carefully designed to be easy to complete and restricted to 5-point scales. The preliminary questionnaire was also discussed with a number of academicians involved in senior administrative posts in HEIs, who had also the experience in QM applications in HEIs. A pilot study based on a series of semi-structured interviews was also conducted in two different schools (schools of business and engineering) of a private university in Istanbul in order to confirm that the items of the questionnaire were clear and unambiguous. Based on their comments, the draft questionnaire was subjected to a series of tests and revisions to arrive at the final form.

The final version of the questionnaire is composed of two main parts. The first part included 50 items that are related to 9 QM practices, and 9 items for stakeholder focus in HEIs. The second part attempts to capture the demographic characteristics of the respondents.

The sampling frame of this survey was composed of the Turkish universities in Istanbul. As of March 2006, there are 93 universities (68 state and 25 private) in Turkey (www.yok.gov.tr) where 22 of them (7 state and 15 private) are alone located in Istanbul. The potential respondents for the survey were identified as the academics that were closely familiar with the university's quality management practices. Eventually, survey questionnaire was mailed to a total of 225 academics identified as potential respondents from 20 universities in Istanbul, which have at least 5 years of educational background.

A total of 155 questionnaires were returned of which 32 of them were eliminated due to largely incomplete or unanswered questions. As a whole the response rate was 0.55 (123/225), which is satisfactory given the nature of respondents.

Measurement of input and output variables

A set of nine QM practices that are applicable to HEI context were identified as input factors. These practices include 'leadership', 'vision', 'measurement and evaluation', 'process control and improvement', 'program design', 'quality system improvement', 'employee involvement', 'recognition and reward', and 'education and training'. Respondents were asked to identify to what extent these QM practices were implemented in their institution relying on five-point scales ranging from 1= 'not at all implemented' to 5= 'fully implemented'. While it is still quite controversial to identify the performance criteria for HEIs, a list of seven performance indicators as output factors was identified for this study. These are 'student focused', 'business focused', 'employee focused', 'students' school preferences', 'average LES (Graduate exam) scores', 'academic/research quality', and 'faculty student ratio'. Respondents were asked to indicate on a 5-point scale, ranging from 'definitely better' through 'about the same' to 'definitely worse' or 'don't know' on how their university had performed over the last 3 years relative to the others on each of these performance criteria. Table 1 indicates the inter-item reliability coefficients (Cronbach alpha) for both input and output factors. Cronbach alpha values range between 0.92 and 0.77 and are all well above the threshold value of 0.70.

Table 1 Internal consistency of the scales

	No. of items	Cronbach's Alpha
Inputs		
1. Leadership	9	0.921
2. Vision	6	0.872
3. Measurement and evaluation	7	0.892
4. Process control and improvement	6	0.839

5. Program design	5	0.845
6. Quality system improvement	3	0.892
7. Employee involvement	6	0.880
8. Recognition and reward	3	0.871
9. Education and training	5	0.848
Outputs		
1. Student focus	4	0.765
2. Business focus	2	0.714
3. Employee focus	3	0.851

The DEA model

DEA is a linear programming based approach for measuring the relative efficiency of organizational units (or in DEA terminology, decision making units, DMUs). Due to its many advantages over traditional methods, DEA has received significant attention in recent years.

In general terms, the efficiency of a particular unit can be defined as a ratio of the value of outputs to the value of inputs, where maximum efficiencies are restricted to 1; thus, the efficiency of a unit must be less than or equal to 1.

In this research, there are 123 respondents who answered the survey for their affiliated university, and serve individually as a DMU in the model. Outputs and inputs are the evaluation of 7 performance indicators and 9 QM practices, respectively. By using DEA, efficiency of each university according to an associated respondent was assessed with respect to the others.

An input oriented DEA model initially developed by Charnes et al. (1978), and referred as CCR in the literature, can be expressed below for *m* outputs, *n* inputs and *k* DMUs:

$$Min\ \theta_o - \varepsilon\left(\sum_{i=1}^{n} e_{io} + \sum_{j=1}^{m} d_{jo}\right) \quad (1)$$

Subject to

$$\sum_{r=1}^{k} \lambda_r x_{ir} + e_{io} = \theta_o x_{io} \qquad i = 1,..., n; \quad (2)$$

$$\sum_{r=1}^{k} \lambda_r y_{jr} - d_{jo} = y_{jo} \qquad j = 1,2,...,m \quad (3)$$

$$e_{io}, d_{jo}, \lambda_r \geq 0 \qquad \text{For all } i, j, r \quad (4)$$

where θ_o is efficiency score for a university by an associated respondent *o* under investigation; x_{io} *and* y_{jo} are observed values of input *i* consumed and output *j* produced by a particular university according to respondent *o* respectively; e_{io} and d_{jo} are the amounts of excess input *i* and deficit output *j* for the university according to respondent *o*; $\varepsilon > 0$ is a predefined non-Archimedean element; λ_r's are the dual variables utilized to construct a composite ideal university to dominate university *r*.

The objective function above assesses the efficiency score (θ_o) of the university according to respondent under consideration. Within the same objective function in case the university is efficient (θ_o =1), all-zero slack values (output deficits and input excesses) are also enforced for full-efficiency. Constraint (2) ensures that the input *i* for firm *o* is a linear combination of the inputs for each university according to respondent (*r*) and the excess input of *i*. Constraint (3) states that the optimal output of *j* for a university according to respondent *o* is a linear combination of the outputs for each university (*r*) minus its slacks. In the optimal solution of model (1-4), DMU according to respondent *o* is efficient if $\theta_o = 1$ and $e_{io} = d_{jo} = 0$ for all *i* and *j* (Cooper et al., 2000). If $\theta_o = 1$ but either e_{io} or d_{jo} is non-zero, the firm *o* is called weakly efficient. The universities found efficient in the solution of the model (1-4) form the efficiency frontier which is called as reference set for universities according to respondent *o*.

The efficiency frontier defined by the above CCR model reveals constant returns to scale (CRS) (Cook and Zhu, 2005). As an extension of CCR DEA model, Banker et al. (1984) referred as BCC model adds the constraint, $\Sigma\ \lambda_r = 1$, for variable returns to scale (VRS).

IV. Results and discussion

Efficiencies of the Universities

Based on the performance indicators used in the study, three models are developed to measure the relative efficiencies of Turkish universities: stakeholder focus, factor efficiency, and combined models. Stakeholder focus model measures the efficiency of QM practices in terms of the following three performance indicators: 'student focus', 'business focus', and 'employee focus'. Factor efficiency model takes into account the different factors such as 'students' school preferences', 'average LES (Graduate exam) scores', 'academic/research quality', and 'faculty student ratio'. Combined model considers all seven performance indicators together. We used (1-4) to derive the efficiency index in each model for universities according to associated respondents and determine their reference sets which universities' efficiencies equal to one (Charnes et al., 1978).

Norman and Stoker (1991) classified the DMUs into four categories, based on the number of occurrences in the reference set and the efficiency index: (i) the robustly efficient units; (ii) the marginally efficient units; (iii) the marginally inefficient units; and (iv) the distinctly inefficient units. The robustly efficient units appear on many reference sets and are likely to remain efficient unless there were major shifts in their fortunes. The marginally efficient units will be in only one or two reference sets (including their own) and would be likely to drop to below 1.0 if there was even a small drop in the value of an output variable (or a small increase in the value of an input variable). The marginally inefficient units would have an efficiency rating in excess of 0.9 (but less than 1.0, or equal to 1.0 for

weakly-efficient firms) and could soon raise their score toward 1.0. The distinctly inefficient units have an efficiency score of less than 0.9, but these units would have difficulty in making themselves efficient in the short term.

Based on the above criteria, we then regroup the whole sample into four categories with respect to the three models above, as shown in Table 2. It is apparent from Table 2 that private universities tend to achieve higher efficiency levels in terms of the implementation of QM practices to be stakeholder focus. In contrast, state universities are more successful to use QM practices for better factor efficiencies, where 73% of private universities are classified as distinctly inefficient.

Table 2. The number and percentage of firms for each efficiency category

	State universities		Private universities		Total
	No.	%	No.	%	
Stakeholder focus model[a]	***63***	***100***	***60***	***100***	***123***
Robustly efficient units	17	26.98	12	20	29
Marginally efficient units	5	7.94	12	20	17
Marginally inefficient units	8	12.70	18	30	26
Distinctly inefficient units	33	52.38	18	30	51
Factor efficiency model[b]	***63***	***100***	***60***	***100***	***123***
Robustly efficient units	15	23.81	4	6.67	19
Marginally efficient units	4	0.07	7	11.67	11
Marginally inefficient units	9	14.29	5	8.33	14
Distinctly inefficient units	35	55.56	44	73.33	79
Combined model[c]	***63***	***100***	***60***	***100***	***123***
Robustly efficient units	21	33.33	12	20.00	33
Marginally efficient units	12	19.05	16	26.67	28
Marginally inefficient units	11	17.46	14	23.33	25
Distinctly inefficient units	19	30.16	18	30.00	37

aχ^2= 11.936; p= 0.008; **b**χ^2= 9.287; p= 0.026; **c**χ^2= 3.342; p= 0.342

Comparisons of returns to scale

DEA may be used under the assumption of constant or variable returns to scale. Banker et al. (1984) classified the scale efficiency of DMUs into three categories: (i) increasing returns to scale (IRS); (ii) constant returns to scale (CRS); and (iii) decreasing returns to scale (DRS).

IRS means that an increase in input will result in a greater than proportionate increase in output, whereas DRS is the case where the result is less than the proportionate increase in output. CRS is exhibited where the result is the proportionate increase in output. Then, both samples have been classified into these three categories by their returns to scale. The numbers and percentages of the universities within these three categories of the returns to scale are shown in Table 3.

Again, using chi-square test for independence, Table 3 indicates that there is a significant variation only in the factor efficiency model in terms of returns to scale ($p<0.05$).

Table 3 also shows the breakdown of both samples of universities based on each category of returns to scale. For each of the groups of output variables in general it would not be unreasonable to argue that private universities have better potential to improve their factor efficiency performance by exerting relatively more effort through incrementing their implementation levels of QM practices.

Table 3. Categories of scale returns for each type of firms

	State universities		Private universities		Total
	No.	%	No.	%	
Stakeholder focus model[a]	***63***	***100***	***60***	***100***	***123***
IRS	12	19.05	6	10.00	18
DRS	27	42.86	27	45.00	54
CRS	24	38.09	27	45.00	51
Factor efficiency model[b]	***63***	***100***	***60***	***100***	***123***
IRS	6	9.52	16	26.67	22
DRS	9	14.29	5	8.33	14
CRS	48	76.19	39	65.00	87
Combined model[c]	***63***	***100***	***60***	***100***	***123***
IRS	3	4.76	3	5.00	6
DRS	23	36.51	21	35.00	44
CRS	37	58.73	36	60.00	73

[a]χ^2= 2.105; p= 0.349; [b]χ^2= 6.550; p= 0.038; [c]χ^2= 0.031; p= 0.984 (2 cells with expected counts less than 5).

Reasons for technical inefficiencies

The input excesses and the output deficits are individually derived for each of the inefficient universities. The results of averaging the input excesses for each input variable are summarized in Table 4. In stakeholder focus model, state universities were not quite efficient to use QM practices to be more stakeholder focused in general. As a result, their input excesses were found to be more than private ones ($p<0.05$). The highest excesses for state universities were found on the following QM practices: 'leadership', and 'quality system improvement'. 'Process control and improvement' was the area where private universities have excessive efforts, but it did not produce appropriate output. 'Employee involvement' has similar characteristics for private universities from the view point of factor-efficiency model.

Table 5 shows the results of the average output deficits for both groups of universities. The most significant output deficits were found for private universities in factor-efficiency model. Based on current level of QM practices, private universities were supposed to show better performance on the following indicators: 'average LES (Graduate exam) scores', 'academic/research quality', and 'faculty student ratio'.

Table 4. The average of input excesses

Input factors	State universities	Private universities	t-value
	Average improvement potential	Average improvement potential	
Stakeholder focus model	**0.233**	**0.190**	**1.973****
Leadership	**0.418**	0.158	4.22***
Vision	0.344	0.275	0.93
Measurement and evaluation	0.180	0.194	-0.22
Process control and improvement	0.059	**0.164**	-2.14**
Program design	0.040	0.072	-0.87
Quality system improvement	**0.440**	0.183	3.46***
Employee involvement	0.194	0.214	-0.35
Recognition and reward	0.149	0.249	-136
Education and training	0.270	0.203	1.07
Factor efficiency model	0.296	0.302	-0.244
Leadership	0.214	0.152	0.99
Vision	0.451	0.386	0.79
Measurement and evaluation	0.509	0.452	0.65
Process control and improvement	0.200	0.192	0.12
Program design	0.166	0.096	1.09
Quality system improvement	0.352	0.369	-0.19
Employee involvement	0.298	**0.463**	-2.07**
Recognition and reward	0.256	0.224	0.42
Education and training	0.213	**0.383**	-1.96*
Combined model	0.164	0.152	0.62
Leadership	0.247	0.123	2.18**
Vision	0.237	0.259	-0.32
Measurement and evaluation	0.152	0.141	0.22
Process control and improvement	0.084	0.121	-0.90
Program design	0.053	0.057	-0.14
Quality system improvement	**0.260**	0.143	1.90*
Employee involvement	0.162	0.169	-0.14
Recognition and reward	0.099	0.183	-1.43
Education and training	0.181	0.175	0.11

*p<0.1; ** p<0.05; ***p<0.01

Table 5. The average of output deficits

Output Factors	State universities	Private universities	t-value
	Average improvement potential	Average improvement potential	
Stakeholder focus model			
Student focus	0.086	0.125	-0.88
Business focus	0.144	0.087	1.12
Employee focus	0.016	0.038	-1.06
Factor efficiency model			
Students' school preferences	**4.057**	2.153	1.71*
Average LES (Graduate exam) scores	1.172	**1.896**	-2.23**
Academic/research quality	0.013	**0.069**	-3.56***
Faculty student ratio	1.114	**2.781**	-2.12**
Combined Model			
Student focus	0.067	0.109	-1.03
Business focus	0.124	0.059	1.32
Employee focus	0.077	0.051	0.64
Students' school preferences	6.886	5.242	0.88
Average LES (Graduate exam) scores	1.604	1.738	-0.30
Academic/research quality	0.065	0.074	-0.38
Faculty student ratio	1.396	**4.760**	-3.08 ***

*p<0.1; ** p<0.05; ***p<0.01

V. Conclusions

In this study, the relative efficiency of Turkish universities with regard to the implementation of quality management practices is measured by data envelopment analysis (DEA). Based on the extant literature, a set of 9 critical quality management factors and 7 performance indicators for Turkish universities are identified for the efficiency model and used as input and output parameters respectively. It was found that state universities were significantly more efficient in terms of the use of QM practices for factor efficiency model. For the same model, 73% of private universities were classified as distinctly inefficient. However, private universities were more efficient to use QM practices in order to focus stakeholders. According to returns to scale analysis for factor efficiency model which was the only statistically significant one, private universities have better potential to improve their factor efficiency performance by exerting relatively more effort through incrementing their implementation levels of QM practices.

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