The relationship between programme management efficiency and evaluation results in an institute of technology: a Taiwanese case

Hsi-Chi Hsiao†, Chien-Hua Shen‡, Chun-Mei Chou*, Su-Chang Chen & Lung-Yu Chang*****

Cheng Shiu University, Kaohsiung, Taiwan†
Transworld Institute of Technology, Yunlin, Taiwan†
National Yunlin University of Science and Technology, Yunlin, Taiwan*
National Penghu University, Penghu, Taiwan**
Takming University of Science and Technology, Taipei, Taiwan***

ABSTRACT: In this study, Data Envelopment Analysis (DEA) was used to explore the relationship between management efficiency and the outcome of performance evaluation carried out by Taiwan's Ministry of Education (MOE) for schools' academic departments. To achieve these objectives, the data from the academic years 2004-2006 was used and analysed that was provided by those 15 academic departments in the case school evaluated by the Ministry of Education in 2007. The results showed that there was no absolute relationship between management efficiency and evaluation grade. The DEA method can also find benchmark departments and suggest improvement directions for other departments.

INTRODUCTION

Technical talents trained through vocational education contribute greatly to industrial development. This is true, especially, with regard to higher vocational education, which provides further educational opportunities for vocational high school students, as well as training for mid- to high-level technical personnel needed by industry. Vocational education in Taiwan has flourished; as of August 2008, there were 158 vocational high schools, 17 vocational colleges, 38 technical institutes and 40 universities of science and technology (Ministry of Education, 2008), training a total of 500,000 technical personnel per year.

As quantity has increased, ensuring quality has become the most urgent issue at hand. The Ministry of Education (MOE), therefore, began evaluating junior colleges of technology in 1975; all vocational schools have since been included in relevant evaluations. Regular evaluations are held every 3-4 years, giving evaluation grades ranging from 1 to 4 in the case of higher vocational education. Evaluations of vocational schools are carried out by teams consisting of members from industry, government, academia and research circles who are invited by the Ministry of Education. The teams perform evaluations based on evaluation criteria and indices, with each member evaluating the school based on his/her field of expertise. As departments' evaluation grades are the result of inter-comparison among schools and not cross-department intra-comparison within a school, one would like to see whether those departments graded as first-rate in the national evaluation manifest high management efficiency. In addition, the first motive of this study was to look for a benchmark department as a paradigm for other departments in the school.

Generally speaking, methods of management evaluation include regression analysis, ratio analysis and Data Envelopment Analysis (DEA). Regression analysis cannot differentiate between high- and low-efficiency organisations and ratio analysis can only deal with a single input and output for a single ratio method, or lacks objectivity in determining the weights of factors for multiple ratio method. Data Envelopment Analysis, however, can consider multiple inputs and outputs simultaneously, determining the efficiency frontiers of all observed values in order to provide a basis for measuring the relative efficiency of each Decision Making Unit (DMU) and, based on this, can suggest improvement strategies [1]. Thus, this study makes use of DEA to understand the management efficiency of 15 departments in the case school and this is the second motive of this study.

In order to improve management quality, units within an organisation can observe and learn from each other. Consequently, this study looks for the most efficient department in the case school through DEA and sets up a benchmark for learning for other departments. This is the third motive of this study.

Based on the above, this study has the following purposes:

1. Using DEA to measure the management efficiency of the departments in the case school and compare the results with the evaluation grades by MOE;
2. Using DEA to compare differences in management efficiency among the departments in the case school and establish a benchmark department;
3. Using DEA to explore the direction and extent of improvement for the departments in the case school.

LITERATURE REVIEW

Indicators of Educational Management Efficiency

Using the DEA method to evaluate department management efficiency, Gu proposed that in examining the efficiency of various departments in teaching and research, input indicators should include staff expense, regular operating expense and capital expenditure. Output indicators should include the number of credit hours and research results [2]. Research on department management efficiency has been ongoing and includes work by Beasley, Johnes and Johnes, Kao, Tomkins and Green, Wang, Chen, Zhang, Mei, and others [3-10]. With the diversification of demands on teacher performance in Taiwan, there has been diversification in terms of output, including such evaluation items as teaching, research and service.

Researchers have pointed out that from the perspective of a strategy, development indicators, which combine formative and summative indicators, should be emphasised [11]. Development indicators refer to internal school personnel establishing development goals and converting performance accountabilities into indicators in response to various types of evaluations. Development indicators must be coordinated with the managerial direction, manpower and managerial needs of the school.

In the 2007 MOE evaluation, evaluation items were classified into department development, curriculum planning, teacher structure and attainment, equipment and library resources, teaching quality, student achievements and development, research and technological advancement, and improvements made according to the previous evaluation's opinions. There were 41 sub-categories in total. For quantitative information, the visited institutions were required to provide 10 items of information: departmental expenditures, number of students, number of teachers, course information, current students' technical licenses, daytime students' careers, teachers' journal publications, teachers' conference paper publications, book publication, patents received, awards and honours information, full-time teachers' performance on government-sponsored projects, and academia-industry cooperation projects, technical service projects, and teacher's academic activities.

In summary, it is mandatory for each individual school to establish development indicators to construct a self-diagnosis and improvement system in order to establish its own developmental characteristics by analysing external evaluation indicators and assessing its own developmental condition.

Benchmarking and School Management

Benchmarking lies in finding an object for learning and using his/her own learning achievements as a benchmark for emulation. Studies by researchers have indicated that benchmarking can actually improve management performance [12]. Benchmarking means changing old mind maps to establish attitudes of cooperative and self-regulated learning. In this study, the perspective of internal benchmarking and applying the DEA method was adopted in an attempt to use representative indicators to compare management performance between departments. Aside from establishing a benchmark department, the approach can also increase experience transmission and sharing between organisational units.

RESEARCH METHOD

There are three main steps in the DEA process: DMU (Decision Making Unit) selection, identification of input and output items and model selection. For DMU selection, this study took the departments evaluated by the MOE in 2007 as the objects of this study. These departments include: Business Management (A), Marketing Management (E), Information Management (L), Finance (F), Accounting (K), Visual Transmission Design (J), Product Design (I), Public Relation Design (B), Applied Foreign Language (M), Tourism And Hospitality Management (O), Beauty Design (G), Child Care (C), Biotechnology (D), Electronic Commerce (H) and Environmental Resource Management (N).

For input and output selection, based on the studies of previous researchers, the basic information provided by the DMUs was used in identifying input and output items. Then, focus group discussion was used to screen input and output items for this study. The resulting input items are: (1) Expenditure, which includes the total of equipment expenditure, operating expenses, and travel and moving expenses; (2) The number of full-time and part-time teachers; (3) The number of full-time assistant professors and above. The output items included: (1) The number of graduates averaged over the past three years; (2) The number of papers published (including journals and conferences); (3) The

number of research projects (including executing government-sponsored projects and academia-industry cooperation projects); (4) Total income from research projects.

DEA Model Selection

In this study, two basic models, CCR and BCC, were used to perform data analysis. CCR operates under a constant-return-of-scale hypothesis, meaning that when all inputs are increased at a fixed rate, output is also increased at the same rate, showing that there is no resource waste. Because there may be a relationship of *increasing* or *diminishing* returns between input and output, BCC is another model accommodated to the relaxed hypotheses; this model can be used to understand which return of scale the DMU belongs to, as well as the degree of adequacy of the resource allocation combination. Both CCR and BCC have been adopted in this study. In choosing between input-oriented and output-oriented models, for the case school the departments therein had better control over output, and so this study uses an output-oriented analysis model as suggested by the researchers [13].

RESULTS AND DISCUSSIONS

Efficiency Analysis and Comparison with MOE Evaluation

In this study, both CCR and BCC were used at the same time to evaluate the production efficiency, various technology efficiencies and the scale efficiency of each DMU in order to determine which DMU exhibited efficiency. DMUs were examined and found to be relatively inefficient; it was determined whether this was in technical efficiency or in scale efficiency. The results of this analysis are as follows:

- *Overall Production Efficiency*: As shown in Table 1, only seven (46.7%) departments were relatively efficient in terms of overall production efficiency. The average overall efficiency value in the case school was 0.928. The average overall production value of relatively inefficient DMUs was 0.866, showing that, compared to more efficient departments (efficiency value=1). On average, there was room for improvement of approximately 13%. This means that, if current outputs were maintained, decreasing inputs by 13% would help the departments attain efficiency.
- *Pure Technical Efficiency*: As shown in Table 1, only Departments H, J, and O did not exhibit pure technical efficiency. Overall, the individual departments of the case school averaged 0.970 for pure technical efficiency; while three relatively inefficient departments in terms of pure technical efficiency had an average efficiency value of 0.848, showing that relatively inefficient departments had room for improvement of 15%.
- *On scale efficiency*: As shown in Table 1, overall departments not exhibiting scale efficiency had an average value of 0.922, requiring an improvement of only 8% in order to reach maximum efficiency.

Table 1: Various efficiency values.

DMU Designation	Overall production efficiency CCR value	Pure technical efficiency BCC value	Scale efficiency value	Evaluation grade
A	1	1	1	First-rate
B	0.923	1	0.923	First-rate
C	0.970	1	0.970	Second-rate
D	1	1	1	Second-rate
E	1	1	1	Second-rate
F	1	1	1	Second-rate
G	0.962	1	0.962	Second-rate
H	0.901	0.906	0.994	First-rate
I	1	1	1	First-rate
J	0.977	0.992	0.985	First-rate
K	0.836	1	0.836	Third-rate
L	1	1	1	First-rate
M	0.720	1	0.720	Second-rate
N	1	1	1	First-rate
O	0.637	0.647	0.985	First-rate
Average value	0.928	0.970	0.958	

The last column shows the evaluation grades published by the MOE in 2008 for all departments. Of all departments which exhibited both technical and scale efficiency, Departments A, I, L and N were evaluated as first-rate; in contrast, Departments D, E and F were evaluated as second-rate. Of the departments which exhibited technical efficiency but not scale efficiency, Department B was evaluated as first-rate. In contrast, Department K was evaluated as third-rate. Departments H, J, O exhibited neither technical nor scale efficiency but were evaluated as first-rate departments. From the above facts, it can be realised that there is no absolute relationship between management efficiency and evaluation grades.

Current vocational school evaluation schemes do not just collect quantitative information but also emphasise qualitative information and the subjective conclusions of evaluation committee members. In addition, good evaluations must generally be performed by professionals [14]. For vocational school performance evaluations conducted by the MOE, an evaluation committee is formed only when needed, and its members generally have more experience being evaluated than actually evaluating others or, worse, have no experience in evaluating others at all. Most evaluation committee members are experts in fields of study or are scholars, and lack adequate evaluation expertise. This may be one reason behind the results of this study. In addition, this study constitutes self-comparison within an organisation, while the MOE evaluation constituted a comparison between different schools across the nation; this may be another reason for the differing results. Another possible reason is that some of the evaluators had good relationships with the staff of the college to be evaluated, which may lead to *colleagues bias*. Furthermore, Chinese culture does not presuppose criticism of others in the case of *losing face*, so this also may mitigate, and be an influencing factor in, any realistic assessment.

Reference Set Analysis and Benchmark Department

As shown in Table 2, Departments A, D, E, I, F, L and N comprised the reference set of the research objects in this study; this means that these departments were the primary learning benchmarks for other departments on management efficiency. According to Norman and Stoker's efficiency strength classification, A, D, E, F and I were considered strongly efficient [15]. Department A had the most counts, meaning that Department A was the most efficient, meaning that this department could be a benchmark for other departments. In examining the reasons behind this, this department did not have more input resources relative to other departments but did produce outputs significantly higher than other departments did. Department A was also graded as first-rate in the evaluation grades published in 2008. Thus, for both external evaluation and internal grading, Department A lives up to its name. Analysis of the evaluation result report for Department A showed that the department has 53 advantages and only 10 aspects for improvement. Most advantages were centred on introducing industrial human resources (mentors), setting up coordinated-teaching programmes, promoting teacher-student short-term workplace experience, and applying industry management methods to department development and student counselling, such as colour management, department development and improvement proposals.

Table 2: Table of reference set for the CCR model.

DMU Designation	Overall production efficiency CCR efficiency value	Reference set	Frequency counts in reference set
A	1	A	9
B	0.923	A、D、F	0
C	0.970	A、I	0
D	1	D	4
E	1	E	4
F	1	F	3
G	0.962	A、D、E	0
H	0.901	A、I、H	0
I	1	I	5
J	0.977	A	0
K	0.836	A、D、F	0
L	1	L	1
M	0.720	A、I	0
N	1	N	1
O	0.637	A、I、H	0

Slack Variable Analysis and Directions for Extents of Improvement

Slack variable analysis focuses on analysing inefficient DMUs to understand what directions and extents of adjustment are needed in resource usage. The suggestions that this study has for the relatively inefficient DMUs on directions and extents of adjustment are shown in Table 3. It was found that for relatively inefficient departments, inputs did not need to be increased. This means that there is no room for hiring additional teachers, especially for Department J, which actually needs a staff reduction. For expenditure, Departments B, J, K and O need expenditure reductions. In respect of outputs, Departments C and G should encourage teachers to publish more papers; and Departments C, J, M and O should pursue more projects. Every department except Department B has a lot of room for improvement on total project funding. Department C is the farthest from the recommended value.

In all, among the relatively inefficient departments, input expenditure should be reduced for Departments other than C, G, H and M. For output, all departments other than Departments B, G, and H should seek out more external projects. For total project funding, all departments other than Department B should seek out additional external funding to input into department development.

CONCLUSIONS AND SUGGESTIONS

Based on the above analyses, the following conclusions can be drawn:

1. It was found that there was inconsistency between evaluation grades and management efficiency of the school departments; this may be attributed to the different purposes that the two indices are designed for, the lack of qualitative indices, the degree of expertise of and the subjective factors involved for evaluators.
2. The primary reason for some departments being relatively efficient was that an appropriate output level could correspond to the input resource level. In this study, it was found that Departments A, D, E, F, I, L and N were units exhibiting management efficiency; the input/output ratios for other relatively inefficient departments were not as ideal, meaning that the efficient departments exhibited higher efficiency in resource allocation and also had better production efficiency relative to other departments.
3. Relatively inefficient departments should make large upward adjustments in outputs. Based on the findings, relatively inefficient departments in the case school should strive to pursue more paper publications, projects and project funding in order to raise efficiency. However, academic research is not their primary mission for staff in vocational schools. They should strive to engage in government-sponsored projects and academia-industry cooperative projects in order to take advantage of external resources to aid in departmental development.

Consequently, this study proposes the following suggestions:

1. Comparing management efficiencies of the departments within the same discipline between schools that received a MOE evaluation in 2007. In this study, self-comparison was employed in the case school. Though a benchmark department was found, if DEA analysis was performed for other departments of the same discipline in another school that had recently received evaluation, then the evaluation grades and the suitability of management efficiency could be compared in order to find a benchmark department for that discipline across the entire nation.
2. Using more diverse information to explore the management performance and influencing factors relating to school organisations. In this study, the Data Envelopment Analysis was used to perform comparison analysis in which data were primarily quantified. Later, qualitative data could be added into the analysis in order to gain a deeper understanding of well-performing departments or ill-performing departments. Variables that could be incorporated include teachers' perception of development of the department, organisational culture, leadership styles of department heads, etc.
3. Establishing reward systems for well-performing departments and organising internal observation/emulation activities. On an annual basis, each school could increase funding in capital expenditure and regular expenses to the best-graded department after DEA analysis. Internal school observation/emulation activities could also be arranged so that this department could be visited, and teachers of this department could be invited to share what they have learnt from work to raise management efficiency of other departments.

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Table 3: Table of slack variables of inefficient DMUs using the CCR model.

DMU Designation	Overall Production Efficiency CCR efficiency value	Input Item						Output Item							
		Number of full- and part-time teacher (I)		Number of teachers assistant professor-level and above (I)		Expenditure (I)		Number of Students (O)		Number of papers published (O)		Number of projects (O)		Total Project funding(O)	
		Original input	Suggested value	Original input	Suggested value	Original input	Suggested value	Original production (OP)	Suggested value (SV)	OP	SV	OP	SV	OP	SV
B	0.923	12	12	2	2	4,093,690	3714127	226	251	2	7.9	8	8.7	1,785,201	1934124
C	0.970	26	26	5	2.4	3,584,516	3,584,516	631	651	7	19.7	2	10.3	65,000	4469334
G	0.962	14	14	5	3.4	4,513,625	4,513,625	258	268	6	13.5	13	13.5	1,651,533	3478147
H	0.901	14	14	3	2.6	3,600,480	3,600,480	321	356	10	15.5	7	7.8	508,110	2278950
J	0.977	51	40.5	3	3	6,278,262	4630233	986	1009	23	27	9	15	731,913	6933153
K	0.836	9	9	1	1	3,481,297	2274262	145	204	4	4.8	4	4.8	638,857	1149996
M	0.720	25	25	3	2.1	3,223,358	3,223,358	313	624	13	18	6	9.7	399,293	4290716
O	0.637	19	19	3	3	5,005,197	4475481	299	470	7	11.9	8	12.57	322,125	2119823

Note: Expenditure is in terms of NTS, (I) denotes input variable and (O) denotes output variable.