A Study of the Performance Evaluation on E-Learning in Public Sectors

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ABSTRACT

In the 21st century, the major competitiveness of a country lies in the talents whose power generated from knowledge would become the most powerful tool, especially the knowledge and competitiveness resulted from e-learning. Aiming at the departments in Kaohsiung City Government, Data Envelopment Analysis (DEA) is applied to the efficiency assessment of e-learning, in which Delphi Method is utilized for selecting inputs, including number of employees, invested costs, management expenses, and output of yearly performance assessment. Sensitivity Analysis is further applied to acquiring the departments with the best efficiency, and individual departments with management efficiency are also analyzed. The research outcomes show that 1.ten departments in Kaohsiung City Government with constant returns to scale achieve the optimization in e-learning efficiency, 2.two departments appear decreasing returns to scale that decreasing the scale might be able to enhance the marginal returns and improve the e-learning efficiency, and 3.eleven departments present increasing returns to scale, showing that the scale could be enlarged to enhance the marginal returns and further promote the efficiency.

Keywords: data envelopment analysis, e-learning, public sectors, city government, employee

RESEARCH BACKGROUND AND PURPOSE

The development of information technology and the popularity of Internet have resulted in the emphasis on e-learning in various countries and fields of education. The services from the government, such as information, knowledge, skills, policies, and regulation propaganda, present brand-new methods through e-learning. In terms of industrial applications, the introduction of e-learning could reduce the training period of employees, break through the restriction on space, and enhance the learning performance. In regard to educational and technological trainings, well-known instructors could be everywhere through e-learning.

National Science Council started promoting Taiwan e-Learning Program in 2002, and Industrial Development Bureau, Ministry of Economic Affairs, also proposed e-Learning Industry Promotion and Development Program and indicated in the investigation that manufacturers in Tree Trillion Industry of semiconductor, flat panel display, and communication intended to introduce e-learning, reflecting the boom of e-learning. Moreover, the investigation of Institute for Information Industry indicated that enterprises in Three Trillion Industry, which had already introduced e-learning, appeared the major effect of Reducing Training Costs and Enlarging Training Areas. As a result, the introduction of e-learning could effectively reduce costs and enhance competitive strengths. With the actively promotion of the government, e-learning is increased the development

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State of the literature

- The services from the government, such as information, knowledge, skills, policies, and regulation propaganda, present brand-new methods through e-learning.
- The introduction of e-learning could effectively reduce costs and enhance competitive strengths. With the actively promotion of the government, e-learning is increased the development space and enhanced the overall development.
- This study therefore analyzes the e-learning efficiency in public sectors, tending to understand the e-learning efficiency and the improvement directions.

Contribution of this paper to the literature

- From the analyses with DEA, the proportion of the departments in Kaohsiung City Government not achieving Scale efficiency is rather high that the inputs for e-learning should be re-considered and adjusted so as to promote the competitiveness.
- It is suggested that the relatively inefficient sectors should pay attention to the number of recruitment, the equipment for e-learning, and the inputs of management expenses in order to reduce the over-waste of resources.

space and enhanced the overall development. E-learning of governmental departments is actively developing under the guidance of Directorate-General Personnel Administration, Executive Yuan, Ministry of Education, and Ministry of Culture. Apparently, e-learning presents specific effects on public sectors and industries under the promotion of the government and the active development of the civil. Nonetheless, the development of e-learning in public sectors is lack of strategic planning and horizontal integration for overall development that the organizations establish e-learning by themselves and merely consider the internal demands. Such development causes repeated development of common curriculum on various websites and abundant hardware equipment which indirectly result in the repeated input and waste of resources. Curriculum with uneven quality not only could not promote the learning performance, but also could cause persecution. This study therefore analyzes the e-learning efficiency in public sectors, tending to understand the e-learning efficiency and the improvement directions. The research outcomes not only could provide direct suggestions for public sectors, but could also be the reference to e-learning for enterprises.

LITERATURE REVIEW

e-Learning

Tsou (2011) considered that the numerous resources of e-learning could be the learning items for individuals and allow people instantaneously receiving the message when necessary and learning from others. Rosenberg (2001) proposed that e-learning was the solutions delivered through Internet technology that three requirements should be presented for enhancing knowledge and promoting performance, namely 1.being networked, as it allowed real-time updating, storing, accessing, transmitting, and sharing instructions or information, 2.applying Internet technology, with which the learning curriculum could be delivered to the end-users of e-learning, and 3.focusing on the broadest view of learning solutions to go beyond the traditional paradigms of training.

In the research report of WR Hambrecht +Co. (2000), e-learning was classified into

1. Computer-based Learning (CBL), in which the learning contents were stored in disks so that people could independently learn with computers, without interacting with others, and the computers did not need to be connected;

2. Web-based Learning (WBL), learning through Internet, including Computer-based Learning;

3. e-Learning, learning through electronic media, including Internet, computers, satellite broadcast, tapes, and interactive disks; and,

4. Distance Learning, in which instructions could be proceeded through e-learning and teaching by correspondence that it covered broader range.

Learning Circuits, a network magazine in the USA, defined e-learning as learners learn by transmitting learning contents through electronic media, such as computers, Internet, recorders, tapes, interactive disks, and satellite broadcast. Banc of America Securities further defined e-learning as the integration of learning and Internet. Cisco defined e-learning as a learning method through Internet, containing the elements of diverse content delivery, managers' experiences, and network communities for enhancing exchange among learners (Huang, 2010). E-learning features to break through the restrictions of space and time in traditional instructions so that learners could learn without being restricted by time and space. E-learning also presents the following characteristics and advantages (Lee, 2009), 1.No problem in learning, as the learning is not restricted by time and space; 2.Searving more people, as it allows infinite people to learn, with highly repeated usability; 3.Highly reusable materials, which could effectively reduce instructional costs; 4.Rich learning resources, as online resources could be utilized as the learning index for enhancing learning effects; 5.Tailored learning contents and process that learners could select curriculum and materials based on personal level and preference, without being instructed with identical teaching plans as in traditional instructions, to achieve the learning effects; 6.Complete record of learning process, which allows learners to understand and inspect the learning process and instructors to master the learning conditions of learners; and, 7.Effective accumulation of knowledge, as for learners, individual knowledge could be effectively and gradually accumulated through complete learning process and systematic learning records, and for enterprises, knowledge could be effectively organized and accumulated and rapidly delivered to employees for practical knowledge management.

Selection of Input and Output Factors

Efficiency is composed of inputs and outputs, meaning the degree of transforming inputs into outputs, i.e. the input-output ratio. Activities of an organization refer to transforming various input resources into outputs, where inputs are the resources contributing to outputs, while outputs are the specific measuring items for achieving the organizational objective. Management efficiency is related to the capability and stability of managers' decision-making that it is the organizational efficiency set by managers' actions and decisions. Management efficiency measured by Data Envelopment Analysis requires the selection of input and output factors so as to effectively evaluate the management efficiency of various Decision-Making Units.

Generally speaking, the selection of input and output factors is considered subjective, which refers to literature review or applies Delphi Method and Adhoc Methods to confirming the input and output factors of an organization. Liu et al. (2010) selected various input and output variables with literature review and further measured the management performance of Credit Department of Fishermen's Associations. In the measurement of efficiency assessment of Credit Department of Farmers' Associations, the measurement of organizational performance of environmental institutes, and the quality of public security in Taiwan, Chang (2009), Huang (2009), and Chang (2010) utilized relevant literatures to select the input and output variables.

In the research on the performance appraisal of social welfare foundations in Taiwan and the relative efficiency assessment of national senior high schools, Chang et al. (2009) and Su et al. (2011) confirmed the input and output factors with expert interviews. Chang et al. (2011) applied Delphi Method to selecting the input and output factors and further measured the efficiency. Nevertheless, the process of Delphi Method is regarded complex and requirrs large amount of time, energy, and costs, the retrieval rate of questionnaires is rather low and likely to distort the experts' opinions, and the questionnaires and the expert opinions are fuzzy that the selection of input and output factors should combine the expert opinions, reduce invested costs, and avoid fuzziness in interviews. In this case, Fuzzy Delphi Method (FDM) is therefore utilized for selecting input and output factors in this study.

RESEARCH DESIGN

When applying Data Envelopment Analysis to process efficiency assessment, each input/output would reduce the discrimination of Data Envelopment Analysis. In this case, 4 inputs and 5 outputs could induce 20 output/input ratios that at least more than two DMUs are required for the discrimination of the model. With DEA to measure e-learning efficiency, appropriate input and output factors should be selected for effectively evaluating the learning performance of DMUs. To combine the selection of input and output factors with expert opinions, reduce invested costs, and avoid fuzziness in the process, Fuzzy Delphi Method is applied to selecting the input and output factors. Total 20 questionnaires are distributed, and 16 copies are retrieved, with the retrieval rate 80%. Fremont et al. (1970) indicated that the public opinions from more than five participants could become the basis for analyses. The interviewed experts in this study cover industries, officials, and academia, who reveal frequent interactions on e-learning that they should present certain representative.

After the computation of Fuzzy Delphi Method, the geometric mean is considered as the common sense for experts evaluating the input and output factors. Besides, the median of the evaluation scores is regarded as the standard to select the input and output factors for measuring the e-learning of Kaohsiung City Government. There are three input/output variables in this study, and, with strict selection, total 23 DMUs are practicable that it corresponds to the rules of experience in Data Envelopment Analysis supported by Golany & Roll (1989).

The data of all variables are acquired from public prospectuses and annual reports. The definitions are shown as below.

I.   Input variables

   1.   Number of employees, the sum of employees.

   2.   E-learning invested costs, the input expenses (equipment and materials) for e-learning of Kaohsiung City Government.

   3.   Management expenses.

II.   Output variables

   1.   Yearly performance assessment, the yearly performance assessment of personnel in various departments of Kaohsiung City Government.

EMPIRICAL ANALYSIS OF E-LEARNING EFFICIENCY

Analysis of e-Learning Efficiency of the Departments in Kaohsiung City Government

With DEA to evaluate the efficiency, the results could assist in understanding the relative efficiency to e-learning between the departments in Kaohsiung City. When the efficiency=1, the DMU achieves the relative efficiency. When the efficiency<1, the DMU is regarded relatively inefficient. The empirical results, **Table 1**, show that ten departments present relative efficiency on management, including 1. Civil Affairs Bureau, 2. Finance Bureau, 3. Education Bureau, 4. Economic Development Bureau, 5. Marine Bureau, 6. Tourism Bureau,7. Urban Development Bureau,8. Labor Affairs Bureau, 9. Department of Health, 10. Information Bureau, and the efficiency achieves 1, showing that the e-learning efficiency of the ten departments reach the ideal state. The rest 13 departments appear worse e-learning efficiency.

Table 1. Relative efficiency of the departments in Kaohsiung City

Sectors in Kaohsiung City	Overall efficiency	Pure technical efficiency	Scale efficiency
Civil Affairs Bureau	1.00	1.00	1.00
Finance Bureau	1.00	1.00	1.00
Education Bureau	1.00	1.00	1.00
Economic Development Bureau	1.00	1.00	1.00
Marine Bureau	1.00	1.00	1.00
Agriculture Bureau	0.83	0.79	0.86
Tourism Bureau	1.00	1.00	1.00
Urban Development Bureau	1.00	1.00	1.00
Public Works Bureau	0.90	0.81	0.85
Water Resources Bureau	0.96	0.95	0.86
Social Affairs Bureau	0.83	0.80	0.88
Labor Affairs Bureau	1.00	1.00	1.00
Police Department	0.70	0.62	0.90
Fire Bureau	0.87	0.82	0.87
Department of Health	1.00	1.00	1.00
Environmental Protection Bureau	0.92	0.90	0.91
Mass Rapid Transit Bureau	0.97	0.95	0.98
Cultural Affairs Bureau	0.99	0.91	1.00
Transportation Bureau	0.83	0.80	0.87
Legal Affairs Bureau	0.97	0.94	0.99
Military Service Bureau	0.99	0.99	0.94
Land Administration Bureau	0.91	0.88	0.92
Information Bureau	1.00	1.00	1.00

Slack Variable Analysis

Regarding the analysis of returns to scale, **Table 2**, ten departments in Kaohsiung City Government reveal constant returns to scale and the e-learning efficiency achieves the optimization. Two departments in Kaohsiung City Government appear decreasing state that the scale should be reduced in order to enhance the marginal returns and improve the e-learning efficiency. The rest eleven departments in Kaohsiung City Government present increasing returns to scale, showing that the scale could be enlarged to enhance the marginal returns and further promote the efficiency.

In regard to Slack Variable Analysis, the improvements for abundant inputs in the departments in Kaohsiung City Government are shown in **Table 2**. Aiming at such departments with abundant inputs, the inputs should be reduced so that the management could achieve the efficiency. Moreover, the ten departments with e-learning efficiency in Kaohsiung City Government have presented the optimal input resources.

Table 2. Improvements for the sectors in Kaohsiung City

Decision-Making Unit (DMU)	Improvement of inputs			Improvement of outputs	Returns to scale
	Number of employees	Costs	Management expenses	Yearly performance	
Civil Affairs Bureau	0	0	0	0	CRS
Finance Bureau	0	0	0	0	CRS
Education Bureau	0	0	0	0	CRS
Economic Development Bureau	0	0	0	0	CRS
Marine Bureau	0	0	0	0	CRS
Agriculture Bureau	-5	-6	-3	-7	DRS
Tourism Bureau	0	0	0	0	CRS
Urban Development Bureau	0	0	0	0	CRS
Public Works Bureau	-3	-3	-1	-2	IRS
Water Resources Bureau	-1	0	0	-1	IRS
Social Affairs Bureau	0	-2	-2	-5	IRS
Labor Affairs Bureau	0	0	0	0	CRS
Police Department	0	-9	-8	-10	IRS
Fire Bureau	0	-3	-1	-2	IRS
Department of Health	0	0	0	0	CRS
Environmental Protection Bureau	0	-1	0	-4	IRS
Mass Rapid Transit Bureau	-1	-1	-2	-3	IRS
Cultural Affairs Bureau	-3	0	0	-3	IRS
Transportation Bureau	-2	0	0	-2	IRS
Legal Affairs Bureau	-4	0	0	-2	DRS
Military Service Bureau	0	-2	-1	0	IRS
Land Administration Bureau	0	-2	-2	-1	IRS
Information Bureau	0	0	0	0	CRS

Data source: Organized in this study

CONCLUSION AND SUGGESTION

According to Kung (2009) and Ma (2010), DMUs are further classified into strong efficiency, marginal efficiency, marginal inefficiency, and distinct efficiency. Strong efficiency shows the efficiency=1 and the slack variable=0, and the DMUs present large strength on exceeding inefficiency. Unless the major change of input and output factors, such sectors could remain the efficiency. Marginal efficiency reveals the efficiency=1 and at least one slack variable≠0. Such sectors could reduce the efficiency below 1 simply by increasing input factors or decreasing output factors. Marginal inefficiency presents the efficiency<1 but >0.9 that the efficiency could easily be enhanced up to 1. When the efficiency<0.9, it is regarded distinctly inefficient. Such sectors might be difficult to become efficient in a short period of time, in which the sectors with the efficiency<0.75 would remain inefficient unless there are major changes in input and output factors.

The efficiencies acquired by DEA and the message received from the variables are classified as in **Table 1**. The management efficiency of ten DMUs reveals strong efficiency, with the efficiency=1, about 13% of all DMUs,

showing the favorably relative efficiency to e-learning. The management efficiency of eight DMUs appears between 0.9 and 1, regarded as marginal inefficiency, about 2% of all DMUs, presenting the relative efficiency to e-learning being easily enhanced. The e-learning efficiency of five DMUs is lower than 0.9, as distinct efficiency, about 88% of all DMUs, where the e-learning efficiency of Police Department appears the lowest 0.70. From the analyses with DEA, the proportion of the departments in Kaohsiung City Government not achieving Scale efficiency is rather high that the inputs for e-learning should be re-considered and adjusted so as to promote the competitiveness. It is therefore suggested that the relatively inefficient sectors should pay attention to the number of recruitment, the equipment for e-learning, and the inputs of management expenses in order to reduce the over-waste of resources.

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