EVALUATION AND SCRUTINY OF THE APPROPRIATE METHOD OF TECHNOLOGY TRANSFER USING DATA ENVELOPMENT ANALYSIS (DEA) METHOD

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Abstract

One of the problems of the developing nations industry is the lack of imported technology transfer's ineffectiveness, which the major reason can be the lack of observing the technology transfer phases or lack of using the proper method technology transfer. The main purpose of this research is using the data envelopment analysis method in order to determine the proper method for technology transfer in country's industry. Considering the aim of the research, it is practical, although considering its method, it is descriptive-analytical, also among different descriptive researching methods it is classified among occasion perusals, and library and field methods were used for data collection. Additionally input and output indicators were extracted by Delphi method, and the data were analyzed with an improper output and assistance of GAMS software, by the DEA method. In this research, the efficiency of the decision maker units in the revenue condition with a variable return to scale are assessed the DEA method. According to the results, in the revenue condition even with a variable return to scale the average is 0.9084 and the efficiency of eight methods among thirteen methods is equal to one. Thus by imparting one of the existed ranking methods in DEA, a model is proposed in order to be able to obtain more accurate results of units ranking. What's more the results show that joint venture is the most proper method of technology transfer and networking is the least useful method.

Keywords: Transfer Technology, Technology Assessment, Efficiency, Undesirable Output, Data Envelopment Analysis, Ranking

Introduction

Nowadays One of the most significant necessities of the developing nations is how to do investments on knowledge and technology fields that regarding to the lack of resources and on the other side of research and technological developments , it did have got noteworthy importance. Thus, considering technology as one of most suitable tools to help this kind of decision making, it

should be mentioned seriously and get used by managers and technology politicians with an unprecedented view. In this research it is attempted to determine the appropriate method to transfer technology and knowledge in our country's industry. By utilizing DEA method which is one of the most useful and precise methods of evaluating efficiency. In this article, whilst the researching target and evaluating items are described, research methodology and an Introduction of the suggested model DEA with unsatisfied outputs to categorize the evaluated branches and items , are all mentioned and finally by implementing and using the AP model. The proper method of transferring knowledge and technology is selected and described.

Introducing the issue

The issue of knowledge transfer is always considered as one of the most important economical for developing nations which are suffering economical crisis and require developing living standards to higher levels. One of the industry problems of those countries is lack of imported knowledge transfer that the phases of knowledge transfer or even not using proper knowledge transfer. Nowadays knowledge and technology is mentioned as a strategic element for developing nations. In the industrially developed nations, achieving and implementing new technology is one of essential methods to gain power, influence and international competence. Regarding to these, developed nations are on point of view that the key to tackle economical and political crises and issues is knowledge transfer and development.

Hence, knowledge transfer as a tool to recover the economical conditions in order to lessen the gaps, is avoidable. However, these transfers should be done particularly not just in order to transferring technical technology and boosting the economical thoughtfulness of the country, but also to lead to achieve the dynamic and observable knowledge.(Ayat& Mollataheri. 2001)

Accordingly, knowledge transfer in IRAN was common from the several following reasons it wasn't Implemented properly to heightens the internal economical thought progress which was required: the complexity and particularity of this issue lack of familiar management to different processes of knowledge transfer – unavailability of precise monitoring and controlling units related to the signed contracts- lack of sufficient research budget in order to establish research and development centers – lack of chose relationship among executive units and universities (Tovfigh. 1994).

Consequently, it is necessary that related managers and expertise whilst find out the current problems contributing , identifying effective reasons of sufficient knowledge transfer , and cons and pros of primary factors of the main methods of knowledge transfer, should also represent a new and appropriate model which can lead to economical activities in the competitive fields. Otherwise, by joining the Global trading organization, our economical conditions will under severe threat. In this research to determine the proper knowledge transfer, the DEA method id used. The efficiency of u set of decision making unit is calculated based on the input and output indicator that then are compared together to see the efficient and ire efficiency units. Furthermore, this scientific and nonparametric method allows managers to be able to associate their resources better evaluation of their units. What's more, the DEA method is not only used to clarify the efficiency, it can be give correct information and various conclusions, it can lead the managers to obtain and specify the subsequent goals and aims.

Therefore the main aspect of research is about how to represent a model for e valuating the relative efficiency and for categorizing the knowledge transfer models. The researched organizations in this article are companies that are allegiant to IRAN's developing and innovating organization industry.

Review of the Literature:

DEA: Data Envelopment Analysis

This is a mathematical based technique which is used to determine relative efficiency of a set of congruent decision making units (Jahanshahlo etal 1998).

The main models of DEA are CCR and BCC that each one can be studied as input- based or output – based (Ahmadpor &Salimi. 2006).

The difference between CCR and BCC is the assumption which is related to the stable or variable efficiency cognate to its scale. In the CCR the assumption is related to the stable efficiency into the scale and about the VCC it is variable efficiency (Mehregan.2003).

AP method:

AP model was introduced in 1993 by Anderson and Peterson to categorize the DMUS. Which can supply the most efficient units by this technique, efficient units can get scones up more than 1 , consequently efficient and inefficient units can be classified.

DEA and undesirable factors:

Generally, in order to evaluate the efficiency of congruent units, DEA increases the output or decreases the input. However, it is attempted by some companies to lessen the un appropriate outputs in order to gain better functions and applications. Briefly, Companies are doing their bests to maximize the proper output and minimizing the inappropriate output. For instance a company who has pollutions and usages with the final product, has both good and load out puts. Undesirable output should be entered into the model accurately, I mean its reduction must help improvements another word, the less input is, better as would be the output. In this case, how we act with proper and inappropriate factors also must be different. Therefore the following suggested model is based on the BCC model:

The proposed BCC model: (In order to evaluate the performance):

In this section , we provide a model for measuring the efficiency of decision making units which is based on the BCC model , that is assumption yield with to variable scale has been used and also one of the outputs is undesirable. In this model D indicates the desirable outputs and ND the undesirable outputs:

$$Min\ \theta$$

s.t

$$\sum_{j=1}^{n} \lambda_j x_{ij} \le \theta\, x_{io} \qquad i = 1,\ldots,m$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \ge y_{ro} \qquad r = 1,\ldots,s \quad \& \quad r \in D$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \le y_{ro} \qquad r = 1,\ldots,s \quad \& \quad r \in ND$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

The proposed AP model: (In order to rank the units):

If after evaluating the performance of units we face a situation where some of the units have efficiency measurement of 1, for ranking these units we need to use super efficient model, in the following model In addition to considering the undesirable output on the basis of A.P model it has been proposed for determining the ranking of units:

$$Min\ \theta$$

s.t

$$\sum_{\substack{j=1 \\ j\neq o}}^{n} \lambda_j x_{ij} \le \theta\, x_{io} \qquad i = 1,\ldots,m$$

$$\sum_{\substack{j=1 \\ j\neq o}}^{n} \lambda_j y_{rj} \ge y_{ro} \qquad r = 1,\ldots,s \quad \& \quad r \in D$$

$$\sum_{\substack{j=1 \\ j\neq o}}^{n} \lambda_j y_{rj} \le y_{ro} \qquad r = 1,\ldots,s \quad \& \quad r \in ND$$

$$\sum_{\substack{j=1 \\ j\neq o}}^{n} \lambda_j = 1$$

Research methodology

This research is practical in terms of purpose and analytical in terms of descriptive type and is implemented as a library on the field. Also in this research the model (BCC with an undesirable output) with the nature of input based is used for evaluating and selecting the desired mode of technology transfer in Iran; the reason for choosing the nature of input for solving this model is that the company managers and decision makers usually have more control over inputs than outputs and also managers have more emphasis on cost control. In order to gather information for basics codification, definitions and theoretical concepts the library resources, and Then for determining the input and output variable, interview tools and Delphi technique have been used. Interview tools in initial stages and Delphi technique in team meetings have been used.

Research theoretical framework

Research theoretical framework, is a conceptual and fundamental model that whole research is based on it and through which the researcher makes a connection among factors which are important in creating the research issue and creates his testable hypotheses.

In this research, two main categories of variables have been studied:

1. Input or Independent variables:

These variables are used as inputs in DEA mathematical models and are those resources used to achieve the desired result in chiding: the cost of technology transfer, man power and technical knowledge.

2. Output or dependent variables:

These variables which are the outputs of DEA mathematical model includes: profit, domestic output rate, and return on capital.

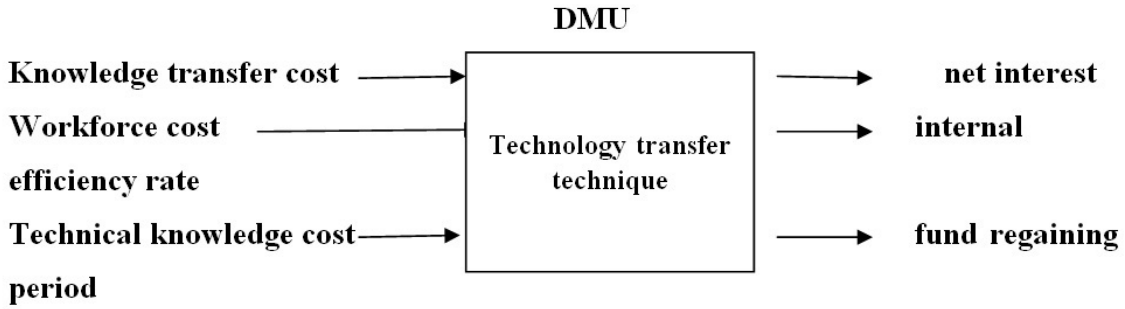


Figure1. Analytical Model

Methods of determining the input and output:

Since the DEA model is a data and output model, in the first step identifying the inputs and outputs is necessary. "There are different methods for survey, getting suggestions and predicting future to assist in decision making. One of these methods which is simple and has a high degree of reliability is Delphi technique. The Delphi techniques are a comprehensive method and one of its applications is to predict the state of a system and how to implement a strategy in the future. This method is used in cases where designing mathematical models and using formulas and rules and obtaining detailed information has limitations and its purpose it to summarize comments, suggestions and judgments of connoisseurs, in fact it is a specialized survey about a subject and coordination to achieve a consensus about it (Ahmadi &Vedai Behyar, 2000).

In the first stage with the study of conducted research inside and outside the country, including: Theses and presented articles, indexes that had been used as input and output was extracted. In the second stage the team of experts was determined. In the third stage by negotiation with each of the experts, purpose, mode of conducting research and DEA model was briefly explained. Then

indexes that were gathered in the first stage was presented to the team of experts in order to study the indexes and select those indexes that are important to them and can be used as input and output and they should also mention the new indexes.
In the fourth stage the early comments of experts about input and output indexes were collected. Then those indexes which according to all experts could not be used as input and output were removed. Again the expert's team was asked to provide their comments about selected indexes. Finally in the fifth stage the expert's comments were studied and following indexes are determined for inputs and outputs.

Conclusions and recommendations:
In this research after collecting information with regard to the limitations related to the input and output variables, for the number of decision making units, some of the variables with higher priority were selected on the bases of Delphi method. Then by formulating 13 models of technology transfer and using GAMS software, we solved these models. While providing a performance evaluation model for units which have assumption yields with variable scale and (also have undesirable output), the ranking of these units has been considered. Innovative aspect of this model is that the same thing can be done for all single industries.

Table (1): Input-output Data and calculation of efficiency of decision-making units

nology trans niques (DM	nology trans ts (million Ri	power co illion Ria	nical knowle s (million Ri	rofit (million F	nal rate of re (percent)	ital return peri (percent)	nical efficienc RS mode BCC
License	209905	3441	21962	145252	27.4	3.5	0.94
Franchise	27568	1738	3720	86899	20.3	4.5	1.00
Merger	77441	4763	12378	305226	31.3	3	0.85
A turnkey	131487	5865	29756	471372	26.4	4	0.64
oint venture	23606	3735	7371	985780	34.99	3.2	1.00
oreign direct investment	576330	5438	2367	670431	23.4	3.3	1.00
Consortium	6123375	23653	26731	2473357	32.7	2.6	1.00
Networking	326775	12354	8976	458400	26.5	4	0.50
Buyback	290876	3980	3766	78943	21.3	3.8	0.88
nical assista d engineerin services	201435	4567	4387	67455	30.2	2.6	1.00

dustrial spie	54690	4570	6794	87387	27.6	2.8	1.00
erse engineer	46809	3655	7688	96708	28.2	3.2	1.00
chinery buyi and imports	8154678	56723	85609	3450871	36.7	4	1.00
Average							0.9084

As it can be seen from the last column of the table, 8 units have efficiency rating 1. Therefore, for ranking them using superefficient models is necessary in AP model is used and we have been able to rank these units efficiently.

Table (2): Final ranking of efficient units using a model (AP with inefficient output)

DMU	License	Franchise	Merger	turnkey	joint ventu	Foreign dire investment	Consortium	Networking	Buyback	Technical sistance an ngineering services	ustrial sp	Reverse ngineering	Machinery uying and imports
aking BC model	9	4	11	12	1	3	8	13	10	2	5	6	7

The results of implementing the model (BCC with an undesirable output) with the nature of the input based indicates that among 13 techniques used in this study 8 techniques have efficiency score of 1 and 5 techniques are inefficient.
Average technical efficiencies were. 19084 which among them, 4 techniques are below the average and 9 of those are more efficient than the average. Also the variation range of efficiency is between 0/50- 10 In other words, 0/6153 of techniques are efficient and the rest inefficient. In this model the efficient techniques includes: Franchise, joint venture, Foreign Direct investment, consortium, Technical assistance and engineering service, Industrial spies, Reverse Engineering, purchasing and importing machinery, and inefficient techniques includes: B.A, Integration, available key, Grill work buy Back The results of the ranking indicate that “joint venture” method are placed in the highest rank and “grillwork” method in the lowest rank.

Suggestions for future researchers:
1. Applying the proposed model to assess all industries of the country.
2. Using this model for technology transfer techniques with other input and output.
3. Efficiency rate and rank of these techniques is one of the criteria for allocating resources of country’s industries in the field of technology transfer.

4. According to the efficiency rate of technology transfer techniques a better choice can be taken in different policies detection of managers of organizations and also can be used by other managers for modeling.

Research suggestions

1. since more accurate are achieved by increasing the number of DMU, conducting a similar research with more DMU is recommended.
2. The amount of data and output of units under different conditions may be fixed. Therefore using fuzzy DEA approach for reflecting the actual conditions of governing on data and output in order to assess the efficiency is recommended.
3. It also can be used to evaluate the efficiency and ranking technology transfer techniques from other ranking methods such as planning and AHP.

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