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A study on performance tracing of the e-MP policy

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ABSTRACT

Since 2000, the Industrial Development Bureau (IDB) of the Government in Taiwan has been implementing a policy of Electronic Manufacturing Promotion (e-MP) to assist firms to implement Business to Business Information System (B2BIS). In general, the actual performance of e-MP policy has just been based on the data given in a final report produced by the funded firm. Consequently there is no clear evidence as to the efficacy of the e-MP policy. Therefore, this paper mainly covers two parts (i) A Fuzzy analytic hierarchical process (Fuzzy AHP) was utilized to explore the weights of each policy item according to project leaders' response of 17 funded cases to see whether the current e-MP policy really benefits firms and (ii) financial data of 30 cases was collected from the stock exchange in Taiwan to understand the actual performance and Fuzzy AHP was utilized to find the funded cases' initial expectation to see whether the adoption of B2BIS by those cases funded by the Government actually met initial expectation. The results of this study indicate that the e-MP policy need to be adjust and costs decreased and work efficiencies rose are most important benefit in most of the funded cases after introduction of B2BIS and this meet their initial expectation. Finally, implications and suggestions are given for the e-MP policy to facilitate adjustments by the IDB.

1. Motivation

A government's efforts in promoting an IT policy not only maximizes infrastructure development but also further induces the diffusion and application of information technology (Tam, 1998). Within this context the Industrial Development Bureau (IDB) of the Ministry of Economic Affairs (MOEA) in the Government of Taiwan has been assisting enterprises to implement Business to Business Information Systems (B2BIS). In 2000 they started supporting these initiatives and formed a commitment in their "e-Manufacturing Promotion (e-MP)" policy (NICI, 2002) which consists of four main policy items (Table 1). In past seven years, the government allocated the majority of resources to technical guidance, and the followed sequence of resources allocation were then the personnel training, the establishment of standards on electronic data exchange, and exhibitions of successful cases.

From Table 1 it can be seen that a total of 65 cases of technical guidance were granted between 2000 and 2006 (IDB, 2007). The objective was to enable large firms to have access to sufficient experience and personnel to assist and train their suppliers to use Internet based business-to-business (B2B) information applications. The firms themselves were responsible for their own internal information systems, such as those involving enterprise resource planning (ERP), which were not covered within the e-MP. In the next paragraph we describe the procedure for applying for funding.

When a firm has decided that they want to apply for funding to implement B2BIS then an implementation proposal is completed and filed with the IDB. A committee is appointed by the IDB who decide whether or not to grant funding. After the project has been executed the committee requests the firm to provide a set of key performance indicators (KPI). Thus, when the KPI are compared against the proposal it is clear whether the initial objectives were met.

However, most KPIs proposed by funded cases related to general finance, as a set of lagging indicators, may not immediately reflect the promotional yield of a recently completed project. In addition the lack of actual operational data leaves considerable ambiguities as to whether the support offered by the e-MP policy has really enhanced the funded cases' operational performance to meet initial expectations.

Furthermore the government has not conducted follow-up studies on performance tracking of the e-MP policy. Therefore in this study we wanted to examine; (i) whether the current e-MP policy benefits firms and (ii) whether the adoption of B2BIS by those cases funded by the Government actually met initial project

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Table 1
Policy items and contents of e-MP.

Policy items	Detail
Technical guidance	Funding to assist major domestic firms to integrate with their suppliers through the establishment of B2B quick response information systems
Establishment of electronic data exchange standards	Facilitate the development by firms of a standard on electronic data exchange
Personnel training	Support for training programs to develop talent to consult, design and operate e-manufacturing systems
Demonstration and exhibition of best practice	Hold of exhibitions, seminars and visits to successful firms of implementing B2BIS

objectives. At first, the fuzzy analytical hierarchical process (Fuzzy AHP) was utilized to understand importance of each e-MP policy item which the funded cases think to see whether the current e-MP policy really benefits firms. The authors also collected the actual financial data of funded cases from the stock exchange in Taiwan in order to understand whether the actual performance of adopting a B2BIS by funded cases actually meet their stated objectives which are KPIs of final report proposed by each funded case. Furthermore, the general performance indicators of implementing B2BIS were collected based on four metrics of the balanced scorecard, and analyzed using the Fuzzy AHP to understand which important indicators are their initial expectation when implementing B2BIS so as to understand whether the actual performance of implementing B2BIS meet their initial expectation. Finally, some implications are analyzed and suggestions are proposed. The research results serve as a reference to the IDB to adjust e-MP policy so as to assist industry more effectively in the future.

2. Literature review

Kuwaiti (2004) found that the design of the performance measurement systems is best performed by a specifically created process. This point was emphasized by Gunasekaran, Patel, and McGaughey (2004) who used related literature and the results from an empirical study to develop a performance measurement framework. Their (Gunasekaran et al., 2004) study provided an understanding of the importance of SC performance measurement and metrics. Wickramatillake, Koh, Gunasekaran, and Arunachalam (2007) also explored the performance measurement methodology used by a case company and used the results to make insights about supply chain performance measurement for large scale projects. With a focus on ERP-based supply chain operators Ho (2007) provided a general guideline to capture the system performance. Chan and Qi (2003) indicated that existing performance measurement theory fails to provide the necessary support for strategy development, decision making, and performance improvement. They (Chan & Qi, 2003) then proposed an innovative performance measurement method to address the judgments and evaluation processes that have to be gone through. Perry, Sohal, and Rumpf (1999) used data from the textile and food industries in Australia to explore project-based KPI data as related to Government policy towards the industry. The literature, given above, focused on the measurement of projects. A follow-up investigation of the post-implementation performance yield following a government promotion has not been reviewed extensively.

3. Methodology

One of the main objectives of this study was to establish the relative weights among B2BIS related the policy items and performance indicators. Since this can be conceptualized as a multicriteria analysis (MCA) problem this lead us to the analytic hierarchical process (AHP) proposed by Saaty (1980). This technique has been widely applied to identify the weight ratios among strategic factors (Moreno-Jiménez & Polasek, 2003; Radcliffe & Schiederjans, 2003). Although the purpose of AHP is to capture experts' knowledge it fails to adequately allow for human cognitive processes. In an attempt to overcome these shortcomings Van Laarhoven and Pedrycz (1983) introduced fuzzy theory. A fuzzy analytic hierarchical process (Fuzzy AHP) can solve otherwise inexplicable problems and rank the excluded factors according to their weightings. This method has become a major research tool in calculating the relevant weightings of perceived significance between factors, and was therefore utilized in this paper. In the next sections we describe the Fuzzy AHP procedures as it was adopted in this study.

- *Establishment of a hierarchy framework*

The establishment of a hierarchy framework is based upon the subject matter of interest and a variety of criteria may coexist. By definition, the statements (i.e., the description of the subject matter) of the sub-criteria should be more specific than those of the criteria.

- *Design of the questionnaire*

The questionnaire used in AHP is used to obtain information about how informants perceive the weight (i.e., importance) of each item statement included in the questionnaire. The informants are asked to compare the paired relative weight among the item statements for a given criterion.

- *Development of fuzzy numbers*

The responses collected from the questionnaire can be formulated as a membership function in a trapezoidal form. Thus, there are four trapezoidal fuzzy numbers: α, β, γ and δ. The minimum and the maximum value of the membership function are represented by α and δ, respectively. Where the level of the membership function equals 1 then β and γ are the smallest value and the largest value of the interval, respectively.

- *Construction of a fuzzy positive reciprocal matrix*

On the basis of the four trapezoidal fuzzy numbers, defined above, we constructed a fuzzy positive reciprocal matrix (A). With a_{ij} as a fuzzy number constructed by sub-criterion i and sub-criterion j, the matrix was defined as follows:

$$a_{ij} = 1 \text{ for } i = j,$$
$$A = [a_{ij}] \text{ where } a_{ij} = (\alpha_{ij}, \beta_{ij}, \gamma_{ij}, \delta_{ij}) \text{ for } i < j,$$
$$a_{ij} = (a_{ij})^{-1} \text{ for } i > j, \text{ where } (a_{ij})^{-1} = (\alpha_{ij}, \beta_{ij}, \gamma_{ij}, \delta_{ij})^{-1}$$
$$= \left(\frac{1}{\delta_{ij}}, \frac{1}{\gamma_{ij}}, \frac{1}{\beta_{ij}}, \frac{1}{\alpha_{ij}}\right) \text{ for } i > j, \quad i = 1, 2, 3, \ldots, n;\ j = 1, 2, 3, \ldots, n.$$

- *Consistency tests*

A consistency index (CI) and consistency ratios (CR) are generally used to check whether there was inconsistent causality or conflicting subjective judgments. The definition of CI and CR are as follows: $CI = (\lambda_{\max} - n)/(n - 1)$ and $CR = (CI/RI_n)$. The positive reciprocal matrix, generated by valuation metrics, yields different CI values at different hierarchical levels. These CI values are called