行政院國家科學委員會專題研究計畫成果報告

應用分析網路程序法於企業資源規劃系統評選之研究

Preparation of NSC Project Reports

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主持人：徐煥智 淡江大學資訊管理系
計畫參與人員：曾素蓉 淡江大學資訊管理系

一、中文摘要

企業資源規劃(ERP)系統的選擇，處於具有大量的替代方案、多條件決策制定，且評估因素彼此互相影響的複雜決策環境下。本研究根據文獻探討歸納出選擇企業資源規劃(ERP)系統的考量因素，並提出一個含四個階段具系統化、多層面的可行性評估模式與系統評選方法。方法中我們利用了析網路程序法(ANP)解決系統具多目標且目標間相互依賴的問題。分析網路程序法是架構於常用的分析層級程序法(AHP)之上，但同時考量了決策相關元素間的交互影響。在實例探討中證實了所提方法之可行性，且能提升企業資源規劃(ERP)系統選擇過程中的決策品質。

關鍵詞：企業資源規劃、分析層級程序法、分析網路程序法，加權計分法

Abstract:

This report illustrates a four steps semi-structured process for ERP system evaluation. To improve the evaluation process, we suggest using Analytic Network Process (ANP) for ERP systems' qualitative review involving multiple criteria and interdependency property. The ANP method is based on the feedback system framework of the well-known Analytic Hierarchy Process. A case study indicates that the evaluated aspects of the method are feasible and improving the quality of ERP system selection compared with traditional approaches.

Keywords: Enterprise Resource Planning, Analytic Hierarchy Process, Analytic Network Process, Weighted Score Method

二、緣由與目的

Today's Enterprise Resource Planning (ERP) systems offer a wide variety of capabilities to support traditional business process areas such as manufacturing, human resources, finance and supply chain management. These systems incorporate with new information technologies such as data warehouses, internet access, client/server or multi-tiers structure to speed decision-making, reduce costs and give managers control over the whole business. It is obviously that successful ERP implementation can gather enormous benefits for companies. However, Holland and Light (Holland and Light, 1999) point out it can be disastrous for organizations that fail to manager the implementation process. Implementing an ERP system induces to massive change that needs to be carefully managed to take advantage of an ERP solution. Critical issues are presented in many previous researches to ensure successful implementation, such as top management commitment, project schedule and plans, personnel, business vision, ERP strategy, consultants, vendors and so

on. (Holland and Light, 1999; Langenwalter, 2000; Bingi et al., 1999).

Prior to the implementation, the system evaluation process must be executed to identify which ERP system is selected. The decision-making process is a critical point in the life cycle of an ERP system. As we know software packages are designed for different target industries and company size; none of them can fit all organizations equally well. ERP system selection deliberately creates the foundation for successful implementation and maximum ROI. Owing to the complexity of the ERP systems and abundance of alternatives, a systematic process of selection can be arduous and expensive. However, when compared to the cost of software, hardware, and risk of failure, the cost is relatively inexpensive. Moreover, the impact of a bad decision strongly influences long-term business success.

With over 300 various ERP providers on the market, there are two critical questions. One is where a company can start their evaluation process and the other is what the whole process is. According to Kontio's (1996) observation in many organizations, the information systems selection process typically is not well defined, each project finds its own approach to it, often under schedule pressure, and there are no mechanisms to learn from previous selection cases. The selection of an appropriate ERP solution is a semi-structured decision problem since only part of the problem can be handled by a definite or accepted procedure such as standard investment calculations. On the other hand the decision maker needs to judge and evaluate all relevant and intangible business impact aspects (Laudon and Laudon, 1998; Bernroider and Koch, 2000). Yet the selection of the right ERP system is often a non-trivial task and requires careful consideration of multiple criteria and careful balancing between business requirements, technical characteristics, and financial issues.

In this study we summarize the ERP system evaluation criteria and reconstruct a semi-structured process for ERP system selection. Specially, we utilize the Analytic Network Process (ANP) model to address the issue of how to generate priorities for decisions involving multiple criteria and general types of dependence of criteria on alternatives, and criteria on criteria in the ERP system selection process. A real case experiment has been done to evaluate the proposed method for rating each alternative against the selection criteria. The results show that the proposed model can produce more relevant information for ERP systems selection and decision makers perceive this information as more reliable.

三、結果與討論

ERP system selection is a semi-structured decision process, which involves multiple objectives or criteria to determining the priority for each system. We proposed a four-step evaluation process.

Step 1: Study strategy and business processes

Step 2: Create screening criteria to conduct a market research and narrow the field to few serious candidates.

Step 3: Rank and select the final lists.

Step 4: Prioritize and bring additional insight to some of the intangibles to select the winner.

The third phase is the first step that the evaluation team is forced to make real comparisons and it is composed of a series of complex review and decision but short of an explicit approach. We determined seven potential ERP system evaluation criteria formally through meetings with engineers, managers and decision

makers in a practical example. The proposed criteria were (1) Cost (CO) (2) easy of implementation (EI) (3) supplier's support (SS) (4) closeness of fit to the company's business (FB) (5) flexibility to easy change as the company's business change (FC) (6) technological risk (TR) (7) System Integration (SI). Among these criteria, there is an existence of interdependence relationship. Figure 1 represents the type of interdependency network. The single arrows imply a one-way relationship. For example, the arrow that leaves from SI and feeds into TR infers that the attributes of criterion SI influence criterion TR.

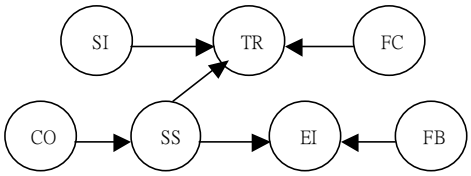

Figure 1. Relationship among criteria

Due to the characteristics of this case study presented here we explore the appropriateness of ANP to allow for the explicit consideration of interactions in the decision making process. The Analytic network process (ANP), which is the extension of AHP, is developed by Saaty (1996, 1999) as well to generate priorities for decisions without making assumptions about a unidirectional hierarchy relationship among decision levels. To take the place of a linear top-to-bottom form of strictly hierarchy, the ANP model provides a looser network structure makes possible the representation of any decision problem. The relative importance or strength of the impacts on a given element is measured on a ratio scale similar to AHP. The major difference between AHP and ANP is that ANP is capable of handling interdependence of higher-level elements from lower level elements and the independence of the elements within a level by obtaining the composite weights through the development of a "supermatrix." The supermatrix is a partitioned matrix, where each submatrix is composed of a set of relationships between two components or clusters in a connection network structure. Saaty (1996) explains the concept corresponding to the markov chain process. We use the matrix manipulation based on the concept of Saaty and Takizawa's (1986) in place of Saaty's suppermatrix in our evaluation process.

During the formal decision-making process, an experiment had been done simultaneously to evaluate the proposed model. Before the ANP model was conducted to the decision-making process, three managers in a decision team were invited to take a pretest using WSM method to evaluate five alternatives independently. Prior the pretest, the managers spent more than 3 hours to discuss the importance of each proposed criteria. After that, they were asked to assign a relative weighted score between one and five to each criterion independently. Once the relative weighted scores were identified, the managers were requested to allocate an additional score between zero and five for each alternative in each criterion as well. According to the WSM method, three sets of overall weighed scores were calculated and represented in Table 1. It appears that managers 1 and 3 assigned the highest weighted score for system A5. However, manager 2 gave the highest weight score to system A2. In addition, systems A2 and A3 have close scores but the weighted priorities

assigned by the three managers are inconsistent.

Table 1

Managers	Alternatives				
	A1	A2	A3	A4	A5
1	103	114	111	106	128
2	92	109	106	94	108
3	88	106	108	91	113

One week later, to let the members in the decision team felt comfortable with the proposed method, they were requested to apply ANP model to conduct a simulated decision-making process based on their currently obtained information. Saaty's proposed 1-9 scale was used in the score assigning process. Since there were seven criteria with interdependence, 33 pairwise comparisons were needed to evaluate their relative importance; and an additional 70 pairwise comparisons were required to evaluate the performance of each alternative on each criterion. In this experiment, three of the managers were asked to perform the process independently as well for the purpose of comparison. After the simulated decision-making process, all the members in the decision team felt to perform the process may cause them fatigue since the large number of individual assessments. However, the managers perceived that the evaluation process is easier compared with the WSM method especially working with our assistant tool. The average time to make a pairwise comparison is less than 30 seconds in this case. As the ANP method produced ratio scale ranking, the surprising result show that the overall priorities for the alternatives identified by the three evaluators are the same (A5>A2>A3>A4>A1). The numbers in Table 2 are the normalized weighted scores for each alternative.

Table 2

Managers	Alternatives				
	A1	A2	A3	A4	A5
1	0.152	0.214	0.202	0.176	0.256
2	0.143	0.223	0.207	0.179	0.248
3	0.154	0.221	0.194	0.169	0.262

A formal group decision meeting was conducted after the experiment. Using the graphical tool, all evaluators discussed and assigned the score for each paired comparison together. The overall duration of the assessment session was shorter than what we expected. They defined the normalized weighted scores for each alternative as (A1, A2, A3, A4, A5)=(0.163, 0.228, 0.193, 0.184, 0.242). Once again, the result presents a consistency with the previous outcome from the individual evaluation process.

四、計畫成果自評

The purpose of this study is to present a method for performing ERP system selection, that allows for the consideration of the effects of interdependence among the decision criteria. Our limited case study is intended to provide practical experience in applying the method and to provide some indication of its feasibility in practice. We find that the ANP method is practical and it may improve the ERP selection process if it is currently conducted in an ad hoc manner. The results of our case study show that ANP method can produce more relevant information for ERP system selection and decision makers perceive this information as more reliable. It also gets our attention that the additional cost of applying ANP is small, compared to the WSM approach. However, when the number of alternatives and criteria are small, WSM may still be a reasonable method to use, provided that its limitations are take into account and compensated. Due to the limited number of data points, i.e., evaluators and cases, the results are not conclusive. We plan to validate our method further.

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