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A real option theoretic fuzzy evaluation model for enterprise resource planning investment

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ABSTRACT

The high failure rate of ERP implementation is due to a common pitfall that ERP projects are often enacted as merely investment into installation of IT infrastructure, rather than systematic planning of operation changes, business process re-engineering and a paradigm shift for the operation and management. To manage ERP investment in a changing environment for high payoff, this paper adopts a real option theoretic method. Fuzzy payoff valuation is introduced to deal with uncertainties in order to minimize the risk of failure. The proposed ERP evaluation model is geared towards small and medium enterprises. A case study is presented to validate the proposed fuzzy real options. The results indicate the potential of modeling ERP investment as "Expand", "Contain" and "Abandon" options in different scenarios. The fuzzy real option model bestows a novel ex-ante cost analysis for justifying ERP investment in the implementation cycle.

Introduction

Enterprise resource planning (ERP) systems are integrated systems proposed for seamless information transfer between business functions, promising to deliver mesmerizing business benefits that include standardizing processes across multiple business units, consistent information base across the entire organization and reducing cost (Lozinsky, 1998; Blackwell et al., 2006; Papiernik, 2001). Successful ERP implementation can achieve operational improvements, including reduction of

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time to market, reduction in cycle time, product development time, improvement in operation, reduction of inventory cost (Stein, 1999) and higher customer satisfaction level (Al-Mashari, 2002). Reaction time to competitive pressures and market opportunities could also be improved by technology (Badawy, 2009). However, these success examples are only minority. Statistical data from the past studies found out that 70% of ERP implementation projects fail to achieve the expected goals set prior to the implementation (Buckhout et al., 1999). Examples of failure are abundant. FoxMeyer Drug went bankrupt in 1996 and filed a US$500 million lawsuit against SAP, blaming for its woes (Key, 1998). Unisource Worldwide, Inc wrote off US$168 million as it abandoned the nationwide implementation of ERP software (Stein, 1998). Dell abandoned the SAP implementation after months of delays and cost overruns, claiming that SAP was too monolithic to be altered for changing business needs. The list continues, but yet does not deter the trend that ERP systems are changing from a competitive advantage to a basic integrated system for enterprises.

To implement a system, decision makers need to consider various aspects such as the corporate requirements, the role of social and intellectual capital in achieving competitive advantages by system (Lengnick-Hall et al., 2004), system performance and infrastructure (Hicks et al., 2010), capability of the vendors (Badawy, 2003), adequacy of training and consultancy. Most of the decision makers need to identify the critical successful factor such as clear understanding of strategic goals, commitment by top management, excellent project management, organizational change management together with the pitfall such as poor planning and management, change in business goals during project and lack of business management support (Umble et al., 2003; Sun et al., 2005; Ngai et al., 2008). The decision makers need to evaluate the risk undertaken by the company and calculate the Return On Investment (ROI). Failure as an implementation that does not achieve the ROI identified in the project approval phase finds that failure rates are in the range of 60–90% (Ptak and Schragenheim, 2000).

In order to minimize the risk, organizations need to select the software carefully and there are various approaches related to ERP selection and assessment. Wang suggested using PERT-embedded genetic algorithm to find out the optimal solution for time–cost–quality (Wang et al., 2008). Mulebeke and Zheng (2006) suggested to use analytical network process for selecting software by considering multi-criteria and multi-attribute factors such as product and technology platform. Other artificial intelligence techniques such as fuzzy logic (Cebeci, 2009; Bueno and Salmeron, 2008; Ordoobadi and Mulvaney, 2001) and neural network (Yazgan et al., 2009; Chang et al., 2008) have been adopted to select the suitable ERP system that meets the corporate strategy and enhances the operation efficiency. Some enterprises may lower the risk by exploring knowledge sharing (Newell et al., 2003; O'Leary, 2002) and studying the user acceptance with technology acceptance model (Bueno and Salmeron, 2008). Predicate/transition net (Hsu and Hsu, 2008) and PDES/STEP (Ming et al., 1998) have been used for ERP modeling with the ability of abstraction and refinement and the configuration support.

There are various research related to ERP implementation, evaluation and technology aspect (Tseng et al., 1999; Ordoobadi and Mulvaney, 2001; Lengnick-Hall et al., 2004). However, there is less research related to guiding the decision makers to understand the value of the alterative options in different economic environment. Wier et al. (2007) analyze interaction between firm size and financial status for ERP adopters with respect to return on asset (ROA), ROI, and return on sales (ROS) and do the comparison about the performance with non adopters. The research proposition that "*The creation of ERP-related operating options will lead to enhanced flexibility in the further deployment of ERPS and/or add-on applications and enhance the value of the ERPS investment.*" (Nicolaou, 2008), is supported based on the argument that Real Option Theory provides a theoretic model and systematic approach to handle ERP investment (Fichman, 2004). It is necessary to minimize the uncertainties to investment-specific skills and strike the balance between risks and benefits (Benaroch, 2002). Real Option Theory is used to analyze and evaluate various options to make budget decisions. In dynamic business environment, decision makers need to realize the benefit and cost of investment by balancing the risk and opportunity. Real Option Theory has been adopted for analysis of IT investment (Kim and Sanders, 2002; Yuan, 2009) such as selection among IT infrastructure (Hilhorst et al., 2008), hospital information systems (Özogul et al., 2009) and ERP systems (Wu et al., 2008).

The implementation cost of ERP system is high for SME and numerous implementation failures have been reported. It is importance to examine on the subject of critical successful factors and risk