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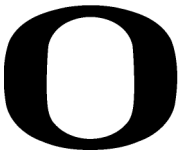

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Master of Science

How to Select an Enterprise Resource Planning System for Small and Medium Enterprises

CAPSTONE 1 Bibliography

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Introduction to the Annotated Bibliography

Problem

Information technology (IT) plays a prominent role in creating competitive advantage for businesses seeking to innovate in response to changing market conditions (Onut & Efendigil, 2010). Traditionally, *competitive advantage* refers to the positioning of a firm in relation to its industry (Bhatt & Grover, 2005). The analysis of the role of IT in creating competitive advantage goes back to the mid 1980s, notably with Porter and Millar's (1985) observations that IT (a) lowers costs at any point in a business value chain and (b) enhances the differentiation strategies available to a firm. More recently, Carr (2003) makes the assertion that IT expenditure no longer provides the competitive advantage it once did for businesses. Carr stipulates that IT investments have become ubiquitous and easily replicated by competitors, thus becoming a commodity that provides no clear advantage for the business. In contrast to Carr's assertion, Bhatt and Grover (2005) believe that competitive advantage from IT is derived directly from how a firm manages and leverages IT capabilities.

When selecting technology to increase competitive advantage, organizations often rely on enterprise resource planning (ERP) systems to enhance data access and better coordinate activities for enhanced operating performance (Bharadwaj, Bharadwaj, & Bendoly, 2007). Onut and Efendigil (2010) describe an ERP system as an "integrated software package composed by a set of standard functional modules" with the intent of "solving various organizational problems" (p. 365). When properly aligned with the business, an ERP system has the potential to help firms improve productivity while mitigating operational challenges throughout the value stream (Ayag & Ozdemir, 2007; Porter & Millar, 1985). According to Karsak and Özogul (2009), businesses seeking advantage in an increasingly competitive and global marketplace turn to ERP systems

for their many tangible and intangible benefits, including (a) the lessening of redundant data entry, (b) improvements in supply chain management, and (c) improvements in decision making that results from inter-functional data flow.

With so much promise placed on ERP systems to provide competitive advantage and mitigate business challenges, small and medium enterprises (SMEs) have begun to adopt enterprise resource planning systems at an ever-increasing rate (Cereola, Wier, & Norman, 2012; Muscatello, Small, & Chen, 2003). Key reasons why SMEs adopt an ERP system include expected improvements in (a) product management, (b) financial management, (c) managerial activities, and (d) responsiveness to market conditions (Iskanius, 2009). While potential improvements that an ERP system may have on SME operations are identified, the risks in implementing such solutions are greater for SMEs than larger firms (Fisher, Fisher, Kiang, & Chi, 2004). Statistically, only 30% of ERP projects are considered successful, as many are (a) over budget, (b) fail to resolve their business objective, or (c) abandoned all together (Iskanius, 2009). Iskanius (2009) goes on to note that the high failure rate of ERP projects for SMEs stems from numerous factors including (a) poor organizational fit, (b) resistance to change by end users, (c) insufficient management support, (d) inadequate training, and (e) a lack of integration with other information systems. For SMEs, resource constraints decrease the capacity to absorb the shock of a failed ERP project, ultimately putting greater weight on the selection of an appropriate ERP system (Muscatello, Small, & Chen, 2003).

Purpose

The selection of an ERP software solution has a significant impact upon the performance of a company (Wieszala, Trzaskalik, & Targiel, 2010). In selecting an ERP solution, it is imperative that businesses choose “the right ERP software package that best meets

the organizational needs and processes that are crucial to ensure minimal modification and successful implementation and use" (Onut & Efendigil, 2010, p. 366).

To help in the selection of an ERP package that is most likely to result in successful implementation, Onut and Efendigil (2010) propose a two-stage approach; the first stage involves product identification and the second stage involves product evaluation. The purpose of this annotated bibliography is to identify published literature that addresses the key criteria for consideration at each stage, i.e., when (a) identifying ERP system options, and (b) evaluating these options for the selection of an ERP system that best meets the needs for small and medium sized enterprises.

References selected for presentation in this study are chosen based on how well they help to illuminate the two-stage approach provided by Onut and Efendigil (2010). For example, concerning stage one (product identification), as noted by these authors, "the objective . . . . . is to select the most appropriate alternative that meets the customer's requirements with respect to cost and quality constraints" (p. 366). This approach also aligns with the goal of Wieszala, Trzaskalik, and Targiel (2010) to identify adequate criteria to support a successful ERP selection, while managing the costs associated from lengthy data and scope analysis.

Concerning stage two (product evaluation), framed within the controls of cost and scope, successful ERP projects need to have an established checklist for system evaluation (Onut & Efendigil, 2010). For example, in keeping with this theme, Malie, Duffy and Van Rensburg (2008) identify ERP selection criteria such as (a) vendor selection, (b) organizational fit, (c) system functionality, and (d) technical compatibility as being important to the development of a reliable checklist. The additional criterion of risk is also identified by Iskanius (2009) as being especially important for SMEs looking to select an ERP system.

Audience

This annotated bibliography is written for executive level managers and IT personnel responsible for selecting an ERP system for a SME. Onut and Efendigil (2010) believe it is imperative that businesses choose the right ERP software package that best meets the organizational needs and processes if they wish to improve the likelihood of implementation success. However, this can be challenging for SMEs, due to lack of technical and financial resources as compared to those available to larger companies (Fisher, Fisher, Kiang, & Chi, 2004). This means that executive managers and IT personnel responsible for selecting an ERP solution within a SME must know how to (a) identify the requirements for the project and (b) understand how these requirements are tied to specific business problems that need to be addressed (Ayag & Ozdemir, 2007). Furthermore, Iskanius (2009) notes that implementation failure often stems from inadequate assessment of the risks involved in the project. This researcher assumes that by taking into account both the needs of the project and the risks involved, those responsible for selecting an ERP system will be better able to evaluate the options, thus improving the likelihood for implementation success.

Research Question and Sub-questions

Main question. What are the key criteria for consideration when (a) identifying ERP system options, and (b) evaluating these options for the selection of an ERP system that best meets the needs for small and medium sized enterprises?

Sub questions. How can ERP selection criteria be weighted to best assess the needs of small and medium sized enterprises? How does risk integrate into the weighting of ERP selection criteria for SMEs?

Search Report

Search strategy. Literature search pertaining to the topic of ERP system selection strategy is constrained to the context of small to medium sized organizations. Literature related to ERP product evaluation is also searched within the context of risk and success vectors. In the larger scope of ERP product evaluation, topics excluded include: (a) installation activities, (b) training, (c) project management, and (d) continuing maintenance (Muscatello, Small & Chen, 2003). The theme of risk and ERP selection is limited to the primary topic of ERP selection criteria and does not pursue risk management strategies beyond identification. The body of literature assembled for this study provides the basis for key selection criteria related to successful ERP selection in SMEs.

Literature collection. Literature pertinent to the topic of ERP selection criteria and additional themes originated from source material obtained through the University of Oregon (UO) online library, interlibrary loans, Google scholar, Gartner.com and general web searches. Preliminary search criteria include the following keywords: (a) ERP selection, (b) ERP implementation, (c) ERP criteria, (d) ERP risk, (e) ERP SME. Relevant search terminology associated with the topic of ERP selection criteria is constructed from the review of the initial literature acquired for this annotated bibliography. Searches utilize the general/interdisciplinary database searches through the UO Library databases and indexes and include (a) Academic Search Premier, (b) JSTOR, (c) Project Muse, and (e) Web of Science. Additional focusing strategies limit searches to the subjects of business and include the databases Business Source Complete and Factiva. The final set of search terms includes:

- ERP selection
- ERP implementation

- ERP criteria
- ERP life cycle
- ERP SME
- ERP risk
- ERP middle market

Literature evaluation. To support research into the topic of ERP selection criteria, preference is given to scholarly articles published in peer-reviewed journals, as described in a set of information evaluation criteria provided through the University of Oregon Libraries website (Bell & Frantz, 2013). References not indicated as peer-reviewed are weighted according to the guidelines set by *Looking* and require alternate credentials such as (a) the origin of the information (i.e. industry expert), (b) research group (e.g. Gartner), or (c) those that provide adequate searchable citations. References not meeting these requirements have been omitted from use.

Timeline. While ERP systems became popular in the enterprise back in the 1990s (Wieszala, Trzaskalik, & Targiel, 2010), the goal of selection of literature for this annotated bibliography is to present current information on ERP selection criteria. To minimize the possibility of presenting obsolete information, search results are limited to the past ten years (2003 to 2013). Exceptions are made for historical context only.

Documentation approach. References acquired electronically are stored locally on a desktop folder for further review. Sources are stored in the Adobe PDF format and are saved under the title for the article. Additional literary source details are stored in an Excel spreadsheet that maintains information on author(s), year published, title, APA citation and abstract. Key articles are printed for efficient markup of relevant information.

Annotated Bibliography

The following 15 references are selected to address the primary research question posed in this scholarly annotated bibliography: What are the key criteria for consideration when (a) identifying ERP system options, and (b) evaluating these options for the selection of an ERP system that best meets the needs for small and medium sized enterprises? Each of the 15 annotation entries contains: (a) full bibliographic citation, (b) published abstract, and (c) a summary. The summary provides a description of the content in each reference that is most relevant to the purpose of this study, which is to examine ERP selection criteria for SMEs and the sub questions of weighting methodology and risk. The references are organized and presented below within three broad themes: (a) ERP selection criteria, (b) ERP criteria weighting strategies, or (c) risk factors. In the event a reference applies to multiple themes, the most prominent theme is utilized.

ERP Selection Criteria

Ayag, Z., & Ozdemir, R. (2007). An intelligent approach to ERP software selection through fuzzy ANP. *International Journal of Production Research, 45*(10), 2169-2194. doi: 10.1080/00207540600724849

Abstract. During the implementations of enterprise resource planning (ERP) systems, most companies have experienced some problems, one of which is how to determine the best ERP software satisfying their needs and expectations. Because improperly selected ERP software may have an impact on the time required, and the costs and market share of a company, selecting the best desirable ERP software has been the most critical problem for a long time. On the other hand, selecting ERP software is a multiple-criteria decision-making (MCDM) problem, and in the literature, many methods have been introduced to

evaluate this kind of problem. In this paper, we use a fuzzy extension of an analytic network process (ANP), which uses uncertain human preferences as input information in the decision-making process, because it can accommodate the variety of interactions, dependencies, and feedback between higher- and lower-level elements. Instead of using the classical eigenvector prioritization method employed in the prioritization stage of ANP, a fuzzy-logic method providing more accuracy on judgments is applied. The resulting fuzzy ANP enhances the potential of the conventional ANP for dealing with imprecise and uncertain human comparison judgments. In short, in this paper, an intelligent approach to ERP software selection through a fuzzy ANP is proposed by taking into consideration quantitative and qualitative elements to evaluate ERP software alternatives.

Summary. This paper explores analytic network process (ANP) with fuzzy extensions as a multiple-criteria decision-making (MCDM) tool. The purpose of this methodology is to present an intelligent way to select an ERP system based on both quantitative and qualitative criteria. The authors present fuzzy logic as a tool to convert qualitative criteria into numbers that can then be utilized to score vendors\ERP source alternatives. ERP selection criteria are gathered through literature review. Once the criteria are established, the authors present their proposed approach for using ANP with fuzzy extension as a tool to select an ERP system. The details of the approach taken by the authors are valuable to the larger theme of ERP selection criteria, particularly as it relates to: (a) the need for cross-functional teams, (b) definition of needs and expectations of an ERP system, and (c) the selection and evaluation of ERP alternatives. The authors support their views by utilizing a case study in relation to their proposed methodology.

Baki, B., & Cakar, K. (2005). Determining the ERP package-selecting criteria: The case of Turkish manufacturing companies. *Business Process Management Journal, 11*(1), 75-86.

Abstract. Purpose - To determine what criteria are used in enterprise resource planning (ERP) selection process and what criteria are the most important for firms. Design/methodology/approach - Through an extensive literature review, 15 selection criteria for the ERP selection process were identified and two were added after initial interviews. A questionnaire including these criteria was formed to secure data from companies. A single informant method was used for each company. To measure the importance of various critical factors a five-point Likert scale was used in the questionnaire. Findings - Fit with parent/allied organization systems is identified as the most important selection criterion. Cross-module integration, compatibility between other systems, and references of the vendor are identified important factors respectively.

Statistically significant differences were also determined between companies using MRP/MRPII versus those using own or no program for "better fit with organizational structure" and "fit with parent/allied organizational systems" criteria. Research limitations/implications - The effect of each selection criterion on ERP implementations failure rates is still to be investigated. Practical implications - Useful information about selection criteria on ERP systems for both vendors and firms planning to use these systems. Originality/value - Two new selection criteria were proposed for the ERP system selection process and some important differences between the criteria used by firms from developed countries and developing countries are determined.

Summary. The overall goal for this research paper is to compile a list of criteria related to ERP selection. Of significance to the topic of ERP selection in this annotated

bibliography is not only the identification of seventeen criteria related to ERP selection, but also the definition of each criterion. In addition to definitions, the authors identify each criterion's impact\effect on successful implementation. To weight the criteria most critical to Turkish manufacturers, the authors use surveys and management interviews to gather data on system requirement and vendor needs. As derived from reviews and interviews, the top three key criteria for ERP selection are: (a) fit with parent/allied system, (b) cross module integration, and (c) compatibility with other systems.

Lall, V. & Teyarachakul, S. (2006). Enterprise resource planning (ERP) system selection: A data envelopment analysis (DEA) approach. *Journal of Computer Information Systems, 47*(1), 123-127.

Abstract. Businesses worldwide have implemented Enterprise Resource Planning (ERP) Systems. ERP systems are a category, of software that offers extensive support to manage business processes. They are application software that can be used in most kinds of businesses and organizations. Adoption and implementation of ERP systems involves risks and a large number of organizations have wasted millions of dollars as a result of failed implementations. Some of these failed implementations may be attributed to the selection of an ineffective ERP system. This paper applies Data Envelopment Analysis (DEA) to the process of selecting an ERP system.

Summary. The purpose of this paper is to present Data Envelopment Analysis (DEA) as a method to help in the system selection process for ERP. The DEA approach is presented as a useful tool in the analysis of weighted criteria and is accomplished by dividing the "weighted sum of outputs by the weighted sum of inputs." (p. 124) DEA is presented as a tool to identify the most efficient system during the final stage of a three-

step selection process that includes: (a) initial criteria filtering phase, (b) candidate evaluation phase, and (c) the final selection phase. From the vendors in the final selection phase, DEA is used to "convert multiple critical attributes into a single relative efficiency measurement" (p.123). To do this, ERP criteria are divided into two broad categories: (a) business objective attributes and (b) vendor attributes. Four criteria are identified as being most prominent to ERP selection, with two being identified as being inputs and two as outputs. Attribute inputs are identified as implementation complexity and cost, while functional match and vendor profile are identified as outputs. The topics presented in this paper add to the themes of ERP selection criteria and criteria weighting methodology relevant to this annotated bibliography.

Malie, M., Duffy, N., & Van Rensburg, A. (2008). Enterprise resource planning solution selection criteria in medium-sized South African companies. *South African Journal of Industrial Engineering, 19*(1), 17-30.

Abstract. The purpose of this study is to identify the factors that medium-sized South African companies consider important in the acquisition of an Enterprise Resource Planning (ERP) solution. Through an extensive literature review, fourteen ERP selection criteria were identified. Using these fourteen criteria, a questionnaire was developed to test and rate these criteria on a 10-point scale. Results from the survey show that manufacturing and non-manufacturing companies rate reliability, compatibility, service, and support as the most important criteria when selecting an ERP solution.

Summary. This study utilizes a literature review and questionnaires to compile a weighted list of key criteria that small and medium sized South African companies consider when selecting an ERP solution. The article provides support for the main

question addressed in this annotated bibliography of ERP selection criteria. Additionally, this study supports the secondary question of how to weight the list for ERP selection. It is observed by the author that three criteria are consistently important among manufacturing and non-manufacturing SMEs including: (a) reliability, (b) compatibility, and (c) service and support. The author proposes that reliability is the key criteria in ERP selection among SMEs due to the "strategic nature" of the technology. Unreliable ERP systems can impact the value of the technology by (a) decreasing confidence of end users, (b) decreasing overall productivity, and (c) impacting the overall ROI of the investment. The author also notes that service and support is rated consistently important due to the "strong correlation" with reliability. Of the fourteen criteria identified, cost is consistently considered to be less of a motivator than expected. The author proposes that the high failure rate (risk) of ERP projects and a desire to see a high ROI on the technology investment are driving factors for this observation.

Ratkevičius, D., Ratkevičius, C., & Skyrius, R (2012). ERP selection criteria: Theoretical and practical views. *Ekonomika, 91*(2). Retrieved from http://www.vu.lt/leidyba//dokumentai/zurnalai/EKONOMIKA/Ekonomika%2091%202/97-116.pdf

Abstract. This article deals with the problems of Enterprise Resource Planning (ERP) system selection as the initial and vital phase of ERP system implementation. Firstly, the paper presents an analysis of different classifications of the fundamental criteria for the ERP system selection process, published in scholar sources, and defines two main groups – software-related, and implementation-related ERP selection criteria. Secondly, combining theoretical and practical approaches, the most significant ERP system

selection criteria of both groups are identified and reviewed by analyzing and interpreting their definitions and differences. The study is complemented by adding practical/statistical findings produced by different consultancies. The paper concludes that there is no standard classification of ERP selection criteria. They are classified mostly on the basis of scientists' research interests. The significance of ERP system functionality as the principal software-related ERP selection criterion is emphasized.

Summary. The authors aggregate numerous studies on ERP selection criteria and present a detailed explanation of the criteria they identify. Of interest is the grouping of selection criteria in two categories: (a) software-related ERP selection criteria and (b) implementation-related ERP selection criteria. This delineation of selection criteria aids in the organization and understanding of the theme of ERP selection criteria gathered for this annotated bibliography. Furthermore, the categories help to identify where each selection criteria will impact the success of an ERP project through the whole of the ERP lifecycle. Where appropriate, the author also explores the risks associated with a given criteria. This adds to the secondary theme of ERP selection and risk. It is concluded that software-related criteria are easier to control due to their technical nature. Additionally, the authors propose the human nature of the implementation-related criteria adds a layer of ambiguity and lack of control that should be addressed more carefully than the software criteria. Finally, the authors acknowledge the need for a quantitative methodology to fully weight and utilize the criteria examined.

ERP Criteria Weighting Strategies

Bueno, S., & Salmeron, J. (2008). Fuzzy modeling enterprise resource planning tool selection. *Computer Standards & Interfaces, 30*(3), 137-147. doi:10.1016/j.csi.2007.08.001

Abstract. ERP tool selection can be seen as one of the most relevant decision-making stages for an organization. This task is conceived as being one of the most difficult ones when an organization is trying to acquire an ERP tool. This work proposes structuring the decision-making selection of ERP tools. With this purpose, we have applied a Fuzzy Cognitive Map based approach capable of offering a definitively organized and structural outline in the acquisition of an ERP tool. Also, this proposed model offers a selection model where the more relevant criteria, their intensity and the relationships between them are identified.

Summary. This paper explores the use of fuzzy cognitive maps as a model for ERP system selection. The authors describe cognitive maps as an approachable model that can aid in the selection on an ERP tool by modeling the factors and relationships that influence decisions making. The process is considered approachable due to its resemblance to the human thought process and its graphical nature. The cognitive mapping process is described as qualitative in nature, and the introduction of fuzzy math is proposed to add a method to weight criteria. The authors note the addition of fuzzy math allows fuzzy cognitive maps to address a wider interpretation of the ERP selection process. Through the use of a case study that involves the input of ten ERP experts, the authors develop a list of 27 ERP selection criteria. Expert consensus helps to group the 27 criteria into one of six constructs: (a) software prestige, (b) software service, (c) similarities to current IT, (d) project cost, (e) implementation efficiency, and (f) company flexibility. The conclusion of the case study is that the process proposed creates a flexible methodology to assist in the selection of an ERP system. This paper contributes to the themes of ERP selection criteria and weighting methodologies.

Fisher, D., Fisher, S., Kiang, M., & Chi, R. (2004). Evaluating mid-level ERP software. *Journal of Computer Information Systems, 45*(1), 38-46. Retrieved from http://web.ebscohost.com.libproxy.uoregon.edu/ehost/pdfviewer/pdfviewer?vid=3&sid=fa636108-22ab-42e1-a99f-2abfcb48c050%40sessionmgr114&hid=123

Abstract. To meet mid-level market demand for Enterprise Resource Planning (ERP) packages, major ERP software vendors have streamlined their products to provide features tailored to the needs of mid-sized organizations. With numerous alternatives available, the selection of the "best" ERP software package is frequently a difficult decision. Oftentimes, mid-sized organizations lack the necessary technical expertise to make such a decision. This study uses Data Envelopment Analysis (DEA) to analyze and compare the performance of several leading mid-level ER-P packages. The DEA model connects costs (inputs) to capabilities/services (outputs) to evaluate the relative performance of individual software packages. Unlike most approaches, DEA does not require a set of pre-assigned weights for inputs and outputs and, thus, overcomes the deficiency introduced by using arbitrary weights. The findings of this study provide information technology managers and consultants a toot for non-subjective assessments of mid-level EPR packages.

Summary. This paper presents methodologies for evaluating ERP software targeted for the mid-size enterprise. The authors present data envelopment analysis (DEA), a non-parametric methodology, as a tool to consecutively evaluating multiple services offered by vendors in relation to cost. DEA uses linear programming to measure efficiencies in decision-making units (DMUs) of multiple inputs and outputs. For this study, the researchers examine the efficiencies of four distinct DMUs: (a) software only, (b)

software with support, (c) software with training, and (d) software with support and training. The researchers utilize these four DMUs to demonstrate how DEA can determine the efficacy of paying for the additional fees associated with each DMU. A main assertion is that the key advantage of DEA is the lack of reliance on pre-assigned weights for criteria and the ability to examine the strengths and weaknesses of criteria in relation to ERP provider peers. This paper supports the theme of ERP selection criteria.

Gürbüz, T., Alptekin, S., & Alptekin, G. (2012). A hybrid MCDM methodology for ERP selection problem with interacting criteria. *Decision Support Systems, 54*(1), 206-214. Retrieved from http://dx.doi.org/10.1016/j.dss.2012.05.006.

Abstract. An enterprise resource planning (ERP) system is an information system to plan and integrate all of an enterprise's subsystems including purchase, production, sales and finance. Adopting such a comprehensive framework may result in the great savings in both costs and man-hours. This research explores the application of a hybrid multi criteria decision-making (MCDM) procedure for the evaluation of various ERP alternatives. The proposed evaluation framework integrates three methodologies: Analytic Network Process (ANP), Choquet integral (CI) and Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH). ANP produces the priorities of alternatives with respect to the interdependent evaluation criteria. The conjunctive or disjunctive behaviors between criteria are determined using MACBETH and CI. Numerical application of the proposed methodology is implemented on the decision-making problem of a firm that faces with four ERP projects. The final ranking is compared to the one obtained by ignoring the interactions among criteria. The results demonstrate that the ignorance of the interactions may lead to erroneous decisions.

Summary. The purpose of this paper is to introduce a hybrid multicriteria decision-making (MCDM) model for ERP selection. To do this, the authors use three evaluation\weighting strategies to build a justification for the approach. The three strategies for the MCDM are: (a) Analytic Network Process (ANP), (b) Choquet Integral (CI), and (c) Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH). ANP is utilized to explore the interdependent qualitative and quantitative evaluation criteria. CI is used to explore the interconnectedness of various criteria and sub criteria. To assist in the use of qualitative data, the multicriteria decision analysis tool MACBETH is used to create quantified data from all selection criteria. The authors present a decision support system flow chart that is helpful in understanding how the proposed tools might be used in a practical manner. For selection criteria, the authors gather information from a literature review. From this review, sixteen selection criteria are identified and grouped into one of three categories: (a) Vendor related criteria, (b) Customer related criteria, and (c) Software related criteria. The authors conclude that ignoring the interrelation of selection criteria can lead to flawed decision making. This paper aids in the development of all three themes of this annotated bibliography, including ERP selection criteria, weighting strategies, and risk.

Karsak, E., & Özogul, C. (2009). An integrated decision making approach for ERP system selection. *Expert Systems with Applications, 36*(1), 660-667. doi: 10.1016/j.eswa.2007.09.016

Abstract. Enterprise resource planning (ERP) systems have gained major prominence by enabling companies to streamline their operations, leverage and integrate business data process. In order to implement an ERP project successfully, it is necessary to select an

ERP system, which can be aligned with the needs of the company. Thus, a robust decision making approach for ERP software selection requires both company needs and characteristics of the ERP system and their interactions to be taken into account. This paper develops a novel decision framework for ERP software selection based on quality function deployment (QFD), fuzzy linear regression and zero-one goal programming. The proposed framework enables both company demands and ERP system characteristics to be considered, and provides the means for incorporating not only the relationships between company demands and ERP system characteristics but also the interactions between ERP system characteristics through adopting the QFD principles. The presented methodology appears as a sound investment decision-making tool for ERP systems as well as other information systems. The potential use of the proposed decision framework is illustrated through an application.

Summary. This article provides a means in which to evaluate multiple ERP vendors in relation to key ERP selection criteria. Of significance to the research question of ERP selection weighting strategies is the organization of key ERP selection criteria into two categories: (a) customer requirements and (b) ERP characteristics. By sorting the key criteria, the authors develop a conceptual map called a House of Quality (HOQ). The HOQ assists in the evaluation of multiple ERP criteria in relation to multiple vendors. Additional ERP selection criteria include (a) Quality Function Deployment, which incorporates information regarding the relationships between user demands and ERP criteria; (b) Fuzzy Linear Regression, which uses qualitative data to find the most suitable ERP alternative; and (c) Zero-one Goal Programming, which seeks to minimize variances

in the information gathered and maximize success vectors. This paper directly relates to the theme of ERP selection criteria weighting.

Onut, S., & Efendigil, T. (2010). A theoretical model design for ERP software selection process under the constraints of cost and quality: A fuzzy approach. *Journal of Intelligent & Fuzzy Systems, 21*(6), 365-378. doi: 10.3233/IFS-2010-0457

Abstract. Enterprise Resource Planning (ERP) software selection is one of the most important decision making issues covering both qualitative and quantitative factors for organizations. Multiple criteria decision making (MCDM) has been found to be a useful approach to analyze these conflicting factors. Qualitative criteria are often accompanied by ambiguities and vagueness. This makes fuzzy logic a more natural approach to this kind of problems. This study presents a beneficial structure to the managers for use in ERP software vendor selection process. In order to evaluate ERP vendors methodologically, a hierarchical framework is also proposed. As a MCDM tool, we used analytic hierarchy process (AHP) and its fuzzy extension to obtain more decisive judgments by prioritizing criteria and assigning weights to the alternatives. The objective of this paper is to select the most appropriate alternative that meets the customer's requirements with respect to cost and quality constraints. In the end of this study, a real-world case study from Turkey is also presented to illustrate efficiency of the methodology and its applicability in practice.

Summary. This paper pertains to the larger discussion of ERP selection criteria and ERP in general. Of particular interest is the decision-making process once the selection criterion has been defined. The authors first explore the selection methodologies for commercial-off-the-shelf software selection and apply the logic to ERP selection.

Following this, the authors present two methods for identifying selection criteria: (a) analytic hierarchy process (AHP) and (b) Fuzzy AHP. Where AHP deals with more quantifiable determinants, Fuzzy AHP deals with more intangible and qualitative criteria. Both methodologies are explored and the final results of both are compared. Fuzzy AHP is presented as a valuable methodology for researchers to work with "vague definition sets." A final practical example is utilized to demonstrate the authors' methodology in relation to the constraints of cost and quality.

Wieszala, P., Trzaskalik, T., & Targiel, K. (2010). Analytic network process in ERP system selection. *International Workshop on Multiple Criteria Decision Making,* 261-286.

Abstract. An Enterprise Resource Planning (ERP) system has a major impact on a company's performance; therefore it is a critical investment. This paper presents a framework for selecting a suitable ERP system using the Analytic Network Process (ANP) methodology. The proposed framework establishes a set of criteria with respect to the support of business goals and enterprise strategies. The method is explained on a numerical example based on the choice of an ERP for a small manufacturing enterprise.

Summary. The authors explore the many selection criteria used by firms when selecting ERP systems. Through a literature review and a case study, the authors identify three clusters of features\criteria used in ERP selection: (a) functionality, (b) technical, and (c) vendor. The authors further expand on the criteria within each cluster, providing a more detailed explanation of the relevance to ERP selection. Discussions concerning the theme of ERP selection and risk management are supplemented in the explanation of individual criterion.

Presented as a less complicated technique than others presented in the literature review, the authors use analytic network process (ANP) to develop a methodology for weighting selection criteria in relation to other criteria. In all, nine steps are outlined for ANP analysis for ERP criteria selection. Furthermore, the authors present ANP as a method to explore the three clusters in relation to competitive alternatives. The exploration of the case study is not only relevant to the practical application of the authors' ideas, but also supplements this annotated bibliography theme of ERP selection criteria for the SME; the case study explored is for a small manufacturing firm.

Risk Factors

Hasibuan, Z., & Dantes, G. (2012). Priority of key success factors (KSFs) on enterprise resource planning (ERP) system implementation life cycle. *Journal of Enterprise Resource Planning Studies, (2012).* 1-15. doi: 10.5171/2012.122627

Abstract. This study presents the priority of key success factors (KSFs) on Enterprise Resource Planning (ERP) system implementation life cycle. There are twenty KSFs considered in this study. They were chosen from literature review. The KSFs are classified into five stages of ERP implementation life cycle; namely: project preparation, technology selection, project formulation, implementation/development and deployment. To address the study objectives, a survey questionnaire was considered the most appropriate research method. It was sent to 74 companies that have been implementing ERP system for at least one year. The respondents are staff at management level, IT staff and users involved in the development and use of the ERP system. The survey received 248 responses from 740 questionnaires that were sent to the companies. To find the priority of KSFs on ERP implementation life cycle, a quantitative analysis is applied to

identify the weighting of KSFs toward ERP implementation success. The success of ERP implementation can be measured through five indicators; namely: system quality, information quality, service quality, tactical impact and strategically impact. This study is expected to improve knowledge in ERP implementation, especially the role of KSF on each stage of ERP implementation life cycle.

Summary. The authors of this study utilize a literature review to support their proposed key success factors (KSF) on ERP implementation life cycle. The key success factors explored by the authors are matched to the five stages of ERP implementation. For this study, the author focuses on the three pre-implementation activities of the ERP life cycle: (a) Project Preparation, (b) Technology Selection, and (c) Project Formulation. Of relevance to this paper is the author's exploration of each section in relation to risk. More specifically, the author's discussion concerning the risks posed by technology infrastructure and the strength of the ERP product are relevant. The author proposes that the technology infrastructure required to host an ERP system responsible for 38.40% of the overall success, while the strength of the ERP option is responsible for 55.40% of the overall success. For managers evaluating ERP solutions, this paper helps to weight the importance of key criteria.

Iskanius, P. (2009). Risk management in ERP project in the context of SMEs. *Engineering Letters*, *17*(4), 266-273. Retrieved from http://www.engineeringletters.com/issues_v17/issue_4/EL_17_4_08.pdf

Abstract. This paper contributes to the discussion on Enterprise Resource Planning (ERP) implementations in the context of small and medium size enterprises (SMEs). Fewer than 30 % of ERP implementations have been successful, meaning the projects

were completed on time, within budget, and with all required characteristics. The principal reason for failure has often been associated with the poor management of ERP implementation projects. Several standardized methods and techniques have been developed to help enterprises to better manage their ERP projects. The purpose of this paper is to identify and assess the main risks in the ERP projects through the case study of three manufacturing SMEs. By using company-specific risk analysis method (RAM), the critical risks of the ERP projects have been identified and assessed. Then, by using characteristics analysis method (CAM), the recommendations of how to divide the ERP projects into manageable sub projects have been given.

Summary. The author presents numerous risk factors related to ERP projects within the SME context. Of particular relevance to the research question of ERP risk factors is the exploration of ERP risk during the selection phase of the ERP lifecycle. Six risk factors related to ERP projects are identified: (a) organization alignment, (b) training, (c) managerial leadership, (d) software design, (e) communication, and (f) technology planning. The author advocates for risk management strategies at each stage of the ERP lifecycle, pointing out that major mistakes often happen during the (pre) selection phase of the project, which is most relevant to this annotated bibliography. Information gathered through case studies, reveals that two of the three firms researched apply to the discussion regarding ERP selection criteria for SMEs (the third firm had already selected and implemented an ERP solutions). ERP selection risk factors identified from the case studies include: (a) misunderstandings between buyers and customers, (b) flexibility, (c) special needs not defined, (d) poor alignment with stakeholders, and (e) selection of the

wrong ERP system. The author also provides thoughts into the unique risks small and medium enterprises face when implementing ERP systems.

Muscatello, J., Small, M., & Chen, I. (2003). Implementing enterprise resource planning (ERP) systems in small and midsize manufacturing firms. *International Journal of Operations & Production Management, 23*(8), 850-871.

Abstract. Enterprise resource planning systems, if implemented successfully, can bestow impressive strategic, operational and information-related benefits to adopting firms. A failed implementation can often spell financial doom. Currently, most of the information about the failures and successes are based on reports on implementations in large manufacturing and service organizations. But enterprise resource planning vendors are now steadily turning their marketing sights on small and medium-sized manufacturers. The time is ripe for researchers to gather, analyze and disseminate information that will help these firms to implement their projects successfully. This research adopts a multiple case study approach to investigate the implementation process in small and midsize manufacturing firms in the U.S. The research focuses on implementation activities that foster successful installations and are developed using information gleaned from our field studies of four projects. Avenues for future research are also suggested.

Summary. This paper explores several activities that influence the success of ERP implementations within small and midsized manufacturing enterprises. The information provided by this paper is derived from numerous case studies and the results of interviews and questionnaires conducted on four different enterprises. The section of the paper that focuses on planning activities adds to an understanding of ERP selection criteria, as well as risk factors. The review of the planning activities data reveals three

items that influence success in the planning phase that include (a) the level of executive leadership, (b) reengineering efforts, and (c) the performance of an enterprise system needs analysis. These early activities are demonstrated to have a profound impact on the success of all following implementation activities. From the enterprise system needs analysis, numerous criteria are found to be common among three out of the four study participants and can be summarized around themes related to technology, business and market analysis, business activities, and financial integration. The author notes that inadequate attention to the needs analysis activity will lead to a poor fit with the ERP software and the organization, jeopardizing the success of the endeavor.

Verville, J., Palanisamy, R., Bernadas, C., & Halingten, A. (2007). ERP acquisition planning: A critical dimension for making the right choice. *Long Range Planning, 40*(1), 45-63. doi: http://dx.doi.org/10.1016/j.lrp.2007.02.002

Abstract. Organizations that invest in new ERP software packages are making a big commitment in terms of both time and money, especially given the complexity of such systems and the risk that their implementation will bring unforeseen problems. This paper looks at the process of planning in the acquisition of ERP systems, basing its findings in an extensive study of four organizations that have gone through the planning process. Six activities are identified and examined: project team formation, requirements definition, establishment of evaluation and selection criteria, marketplace analysis, choice of acquisition strategy, and anticipated acquisition issues. By planning the acquisition systematically and thoroughly, organizations can substantially increase the likelihood that they will identify ERP software and vendors that genuinely meet their needs.

Summary. The focus of this paper is on the acquisition phase of the ERP life cycle. Of the six activities identified by the author in the acquisition phase, the establishment of evaluation criteria directly applies to the topic of ERP risk and ERP selection criteria. This paper explores the impact of downstream acquisition activities (i.e., defining requirements) on ERP selection criteria, as well as the impact of selection activities on upstream activities related to vendor evaluation. Based on information gathered from a literature review and the survey answers of four companies that recently went through ERP planning exercises, three key evaluation criteria are presented by the author: (a) vendor characteristics, (b) functionalities that support an ROI, and (c) established technical future roadmaps. The author also postulates that the criterion of cost is more of a key factor for small and medium sized companies. Throughout the paper, the author's links back all acquisition planning activities as being a risk mitigation tool to manage the complexity of ERP software projects.

Conclusions

As proposed by Onut and Efendigil (2010), to select an ERP package that is most likely to result in successful implementation, businesses should follow a two-stage approach. The first stage involves product identification and the second stage involves product evaluation. This annotated bibliography utilizes published literature to explore the key criteria for consideration when (a) identifying ERP system options, and (b) evaluating the options to best support the needs for small and medium sized enterprises.

According to Baki and Cakar (2005), the selection of the right ERP solution is a critical factor for ERP implementation success. Onut and Efendigil (2010) propose a two-step approach to ERP selection that involves (a) the identification and (b) the evaluation of the selection criteria relevant to a successful ERP implementation. The purpose of this annotated bibliography is to identify published literature that addresses considerations when: (a) identifying and compiling a list of the key criteria relevant to a successful ERP selection and (b) identifying methods to evaluate the criteria as it related to small and medium sized enterprises. The references selected for the annotated bibliography are designed to support individuals in a small and medium sized business tasked with ERP selection activities.

Key ERP Selection Criteria

The selection of the right ERP package is critical for a successful implementation (Baki & Cakar, 2005). To attain a good fit, people tasked with selecting an ERP system need to develop a list of criteria with which to assess alternatives within the marketplace. There are numerous recommendations of selection criteria for ERP systems in the published literature. Baki and Cakar (2005) present a list of seventeen criteria that they assert are key to a successful ERP implementation. Building upon the work of Baki and Cakar with a focus on small to

medium sized businesses, Malie, Duffy and Rensburg (2008) present fourteen criteria that they state are key to ERP implementation success. Verville, Palanisamy, Bernadas and Halingten (2007) propose Hects' six main selection criteria of (a) functionality, (b) technical architecture, (c) cost, (d) service and support, (e) ability to execute and (f) vision as being crucial to ERP selection success, with cost and adaptability being more relevant to SMEs.

Buena and Salmeron (2008) propose a distinction between the criteria as a means to make the information more accessible to decision makers; they identify twenty-seven criteria, which they divide into two groups: (a) selection criteria related to ERP systems and (b) selection criteria related to the organization. Additionally, Buena and Salmeron group the criteria into six categories: (a) software prestige, (b) software services, (c) similarity to current IS/IT infrastructure, (d) project cost, (e) implementation efficiency, and (f) company flexibility capacity. Onut and Efedigil (2010) examine and discern the key criteria for successful ERP selection, first by defining three criteria: (a) quality, (b) cost and (c) vendor reputation. Onut and Efedigil further explore the three criteria by proposing an additional 10 sub-criteria, six related to quality and two each for cost and vendor reputation. Hasibuan and Dantes (2012) identify twenty-one key criteria categorized by (a) people, (b) process organization, and (c) technology. Wieszala, Trzaskalik, and Targiel (2010) sort thirteen key criteria based on (a) functionality, (b) technical features, and (c) vendor factors.

Malie, Duffy and Rensburg (2008) acknowledge that numerous researchers have sought to identify ERP selection criteria, while Buena and Salmeron (2008) propose the need to distinguish criteria as a means to make the information more accessible. With the goal of making the selection criteria more accessible to decision makers in SMEs, the following criteria most pertinent to SMEs are presented (see Tables 1 through 4). It is essential that businesses identify

ERP selection criteria relevant to the organization. The following tables identify fifteen criteria that align well with ERP selection criteria for a SME as outlined by Malie, Duffy, and Van Rensburg (2008) and other researchers they surveyed. Criteria are organized into four categories to support the dissemination of information by SME managers charged with ERP selection decision making activities. The four categories are developed from the literature reviewed in this annotated bibliography. The first three categories (technology, vendor, and cost) are derived from a set of criteria presented by Onut and Efendigil (2010), addressing quality, reputation, and cost. The fourth category (organization) is constructed from the work of Baki and Cakar (2005) and Malie, Duffy, and Van Rensburg (2008).

Table 1.

Technology Criteria

The technical criteria that accompanies an ERP system has a direct impact on the productivity level of the organization (Ratkevičius, Ratkevičius, & Skyrius, 2012). As noted by Iskanius (2009), a failure to properly account for technical criteria is a key risk for SMEs selecting an ERP solution. Technical criteria represent the functionality, usability and overall resilience of the system (Ayag & Ozdemir, 2007; Malie, Duffy & Rensburg, 2008; Onut & Efendigil (2010).

Functional Features	The number of features determines the functionality, usability and scope of the ERP system (Wieszala, Trzaskalik, & Targiel, 2010). The functional features of the ERP software are considered to be the most important feature for SMEs and are key to the value and likelihood of success of the overall investment (Iskanius, 2009).
Technical Options	Criteria related to operating system, scalability, fault tolerance

	and security (Baki & Cakar, 2005.; Malie, Duffy & Van Rensburg, 2008).
Reliability	System resilience from faults caused by hardware, software or user actions (Malie, Duffy, & Van Rensburg, 2008).
Usability	System design elements that enable\detract from users learning and using the ERP system selected (Onut &Efendigil, 2010).
Compatibility	Businesses need ERP systems to interact with other internal systems and\or with a parent company or allied business system. Compatibility determines the degree in which the ERP system can interact with other applications and is considered a key criteria to SMEs (Malie, Duffy, &Van Rensburg, 2008).
Flexibility	The degree and difficulty in which an organization can modify the ERP software to fit a business need\process (Malie, Duffy, & Van Rensburg, 2008).

Table 2.

Vendor Criteria

The importance of selecting an appropriate ERP vendor is noted by Ratkevičius, Ratkevičius, and Skyrius (2012). Iskanius (2009) also lists vendor fit as being a key risk factor for ERP projects. For SME's seeking to implement an ERP, limited technical resources necessitate strong vendor support (Fisher, Fisher, Kiang, and Chi, 2004).

Alignment	Refers to the alignment of the ERP vendor with, and specialized knowledge of, the acquiring businesses industry (Malie, Duffy, and Van Rensburg, 2008; Baki & Cakar, 2005). Closer

	alignment of vendors and customers decreases the need for customization and third party solutions.
Service & Support	The degree in which a vendor is capable of supporting the ERP package during and after implementation. The level of support from vendors impact the technical flexibility (modification and integration) of the package (Baki & Cakar, 2005).
Market Position & Vision	The current and future market position of the ERP vendor can have a direct impact on the scalability, usability and longevity of the software once implemented (Malie, Duffy, and Van Rensburg, 2008; Baki & Cakar, 2005).
Reputation	Knowing the reputation of the vendor and the number of successful deployments is valuable when evaluating ERP suppliers (Baki & Cakar, 2005). Malie, Duffy, and Van Rensburg (2008) stress the importance of getting objective information related to vendor success and failures.

Table 3.

Cost

Verville, Palansamy, Bernadas, and Halingten (2007) note that the cost of ERP software has a greater impact on the survival of SMEs versus larger organizations. The authors note that SMEs have less ability to absorb the shock of a failed implementation than do larger organizations. SMEs seeking an ERP solution need to set realistic cost requirements to maintain the affordability of the solution (Baki & Cakar, 2005).

Purchasing	Often cited as a key criteria for ERP selection, the cost to

	purchase an ERP solution should take into account (a) software, (b) hardware, (c) upgrades, and (d) maintenance activities (Baki & Cakar, 2005; Malie, Duffy, and Van Rensburg, 2008).
Time	The implementation of an ERP solution is a costly proposition that impacts all aspects of a business's activities (Baki & Cakar, 2005). Extended implementations run the risk of accruing indirect costs from key human resources being tied up while assigned to the project (Malie, Duffy, and Van Rensburg, 2008).
Consultants	While the use of consultants comes at a cost, the expertise provided can reduce cost by selecting ERP solutions better aligned with the business, which can help to reduce the overall implementation time (Baki & Cakar, 2005).

Table 4.

Organization

Iskanius (2009) notes that the fit between an ERP solution and the organization implementing it is the most important selection criteria. A closely aligned ERP solution reduces the required changes necessary to software and to the organization, reducing the time to implementation.

Organizational Fit	Malie, Duffy, and Van Rensburg (2008) propose the level of alignment an ERP solution has with an organization's business structure can impact the overall likelihood of success. Additionally, organizational fit impacts the number and degree of modifications that may be necessary for an ERP solution to be usable by a business.

Alignment with Parent and Allied Organizations	The degree in which an ERP solution is capable of performing business-to-business activities is seen as a key criteria towards gaining competitive advantage within a given marketplace (Malie, Duffy, and Van Rensburg, 2008).

Evaluation and Weighting of ERP Criteria

The first step in selecting an ERP solution is to define the criteria by which to measure alternative software solutions. Once defined, a method is required to weight criteria relative to the needs of the business (Iskanius, 2009). Additionally, the process of weighting criteria is valuable when comparing alternative ERP solutions (Onut and Efendigil, 2010). The following section explores the various methods proposed to weight ERP selection criteria, including how to gather, analyze, and evaluate relevant information so that informed decisions can be made.

Data gathering. A common method to develop weights for ERP selection criteria involves getting feedback from businesses and vendors that have experience implementing ERP solutions. Several researchers suggest compiling qualitative linguistic data with an assigned value and then preforming a quantitative analysis on the results. Malie, Duffy and Van Rensburg (2008) discuss collected data from the surveys returned from thirty manufacturing and fifty non-manufacturing SMEs in South Africa. The results from the surveys demonstrate that criteria weights differ between manufacturing and non-manufacturing South African SMEs. Hasibuan and Dantes (2012) also compile weighting criteria from 248 respondents from thirty-seven companies that recently implemented an ERP project. Baki and Cakar (2005) gathered weight criteria by surveying fifty-five Turkish manufacturing companies. Hasibuan and Dantes (2012) propose that the survey method is the most appropriate to gather useful data.

Another method utilized to gather weighting information for ERP selection comes from interviewing decision makers and experts. Bueno and Salmeron (2008) weight the importance of ERP selection criteria by interviewing ten experts in the ERP field. The results of the qualitative interviews were assigned values that could be used with a fuzzy cognitive map technique to weight the criteria. Hasibuan and Dantes (2012) also perform interviews with several ERP consultants to gather further details regarding ERP selection criteria.

Evaluation. Employing one or both of the previous techniques, researchers often will gather inputs for use in analysis and evaluation of ERP selection criteria. In the analysis and evaluation of ERP selection criteria, researchers propose numerous methodologies to evaluate criteria and utilize it to find the best fitting ERP solution (see Table 5).

Table 5.

Evaluation Methodologies

Mean Calculations	Baki and Cakar (2005) devise a method for weighting criteria that averages the results of questionnaires sent to Turkish manufacturing companies. Means and standard deviations are used to rank the importance of ERP selection criteria. Malie, Duffy and Van Rensburg (2008) also develop mean scores, but do so by examining the differences between manufacturing and non-manufacturing SMEs. Hasibuan and Dantes (2012) utilize statistical analysis by employing a Pearson correlation test to identify the degree of correlation between key success factors.
Cognitive Mapping	Bueno and Salmeron (2008) propose the use of a cognitive map as a tool to determine how ERP selection criteria relate to final

	ERP selection. The value of this tool is extended when the weighting of ERP selection criteria is based on information gathered from industry experts. The qualitative nature of the interview questions is further analyzed using fuzzy logic. The authors contend that fuzzy logic provides a means to quantify the relationships between the variables being examined.
Data Envelope Analysis (DEA)	Proposed by Fisher, Fisher, Kiang and Chi (2004) and Lall and Teyarachakul (2006) as a mathematical technique to best evaluate the combination of performance attributes between vendors, this process acknowledges the importance of both qualitative and quantitative data, and utilizes the multiple inputs and outputs gathered from selection criteria to support decision making activities. Fisher, Fisher, Kiang and Chi (2004) gather inputs for key selection criteria based on a literature review.
Analytic Hierarchy Process (AHP)	Onut and Efendigil (2010) propose the use of the multicriteria decision making (MCDM) tool AHP and its fuzzy extensions in the evaluation of ERP packages. A key assumption of AHP methodology is that all decision making criteria are independent and structured in a hierarchy. The processes involves the conversion of linguistic information regarding criteria, usually gathered from surveys, into fuzzy numbers. The fuzzy numbers are then applied to the AHP calculations which then provides clear and concise weighted values for criteria. The assignment

of fuzzy numbers is done by the researcher who develops a chart to quantify the linguistic values returned from the surveys. In Onut and Efendigil (2010) example, odd values (1, 3 5, 7, 9) were assigned to survey linguistic results for ERP criteria importance, while even numbers (2, 4, 6, 8) were used as intermediate values between two adjacent judgments. Table 5.1 demonstrates how linguistic information is converted to a numerical rating for further evaluation.

Table 5.1

Onut and Efendigil (2010) Linguistic Variables

Criteria Linguistic Scale	Numerical Ratings for AHP
Just Equal to Equal Importance	1
Weak Importance over alternative	3
Strong Importance	5
Very Strong Importance	7
Extremely Preferred	9

The numerical values derived from this process are then used to compare ERP alternatives in relation to selection criteria using fuzzy AHP methodology.

Analytic Network Process (ANP)

Unlike AHP, ANP (a subset of AHP) can be utilized to support the evaluation\weighing of criteria in relation to other criteria

relevant to final decision-making. ANP is structured like a network and can accommodate interdependent variables in the decision making process Ayag and Ozdemir (2007). For ERP selection criteria, technical criteria can be evaluated in terms of cost to look for acceptable tradeoffs. Wieszala, Trzaskalik, & Targiel (2010) utilize ANP to explore selection criteria in relation to ERP vendors. Ayag and Ozdemir (2007) propose using fuzzy extension for ANP to support the use of imprecise decision maker judgments regarding ERP selection criteria used in decision-making. Gürbüz,, Alptekin, and Alptekin (2012) also propose the use of ANP, but in conjunction with Choquet Integral (CI) and Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH) to create a MCDM method. All techniques support the evaluation of criteria in relation to other variables.

The key selection evaluation methods explored in Table 5 can all be useful to SMEs seeking to adopt an ERP system. While each selection criteria may be important, the research is unclear as to which ones are the most important. In one study performed in South Africa, reliability, service and support, and compatibility are found to be consistently the most important attributes across manufacturing and non-manufacturing firms (Malie, Duffy & Van Rensburg, (2008). In Turkey, alignment with parent organization, cross module integration, and compatibility with other systems are identified in a study as the most important criteria (Baki and

Cakar, (2005). Other research demonstrates that selection criteria are often subjective in nature, and weighting activities are dependent on the individual needs of the organization (Wieszala, Trzaskalik, & Targiel, 2010).

For businesses considering an ERP system, key variables relevant to the organization should first be defined. Once a list of key criteria is compiled, decision makers will need to weight the criteria to evaluate the best options relative to the needs of the organization. Qualitative surveys regarding ERP criteria allow decision makers to gain insight into the needs of the organization. The translation of qualitative linguistic responses into numerical ratings allow researchers to quantitatively evaluate ERP selection criteria. For simple weighting of criteria, finding the mean values may be adequate. For comparing selection criteria in relation to alternative ERP packages, more complex decision making models are necessary. Tools such as DEA, AHP and ANP provided decision maker's tools to evaluate increasingly complex evaluations.

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