



**LUND UNIVERSITY**  
School of Economics and Management

**Department of Informatics**

# **How SMEs make their decision for choosing an optimal ERP provider by using AHP method**

Master thesis, 15 credits, INF M02, in Informatics

Presented: June, 2010

Authors: Patchara Boonyaprasit

Sen Yang

Supervisor: Bo Andersson

Examiner: Lars Fernebro

Magnus Wärja

## **Abstract**

**Title:** How SMEs make their decision for choosing an optimal ERP provider by using AHP method

**Authors:** Patchara Boonyaprasit & Sen Yang

**Publisher:** Department of Informatics, Lund University

**Supervisor:** Bo Andersson

**Examiner:** Lars Fernebro & Magnus Wärja

**Submitted:** June, 2010.

**Level:** Masters

**Language:** English

**Keywords:** Enterprise Resource Planning (ERP), Small- and Medium-sized Enterprises (SMEs), Analytic Hierarchy Process (AHP), ERP provider

**Abstract:** Nowadays, most small- and medium-sized enterprises (SMEs) are seeking information technique(s) or packaged software for improving their market competitiveness. Enterprise Resource Planning (ERP) system could be a good choice regarding it is a powerful system which is integrated software for operating different perspective of a business, all information within organization would be flow between each organization's modules. There are numerous of ERP providers on the market, previously they were focusing on large organization but now, the attention are moving toward SMEs business by offering cheaper and flexible solutions. To be success in implementation, an appropriated ERP system is required. Nevertheless, an Analytic Hierarchy Process (AHP) method should be able to provide the optimal solution for SMEs suggested by the authors. This study employed a quantitative survey and followed by qualitative interviews which aim to confirm the data and information from the survey. The questionnaires were sent to SMEs' IS managers and relevant employees in China regards to which criteria they focus on when selecting an ERP provider. The thesis concludes that our respondent give more consideration to the facts of Implementation and Flexibility among other criteria when choosing an ERP provider. Moreover, a systematic method for selecting an ERP system for SMEs is proposed and presented in this research.

## **Acknowledgement**

We would like to give our thanks to ABAS (Shanghai, China) Co., Ltd. for their support and help in identifying the current phenomena and trend around SMEs regards to ERP system selection. We would also like to show our gratitude to the CEO in ABAS (Shanghai, China) Co., Ltd. and the IS manager in company X for their great help and participation in the interview. We are grateful to all the members who participated in the questionnaire and also helped spread the questionnaire.

This thesis would not have been possible unless the help from our supervisor Bo Andersson who gave us his excellent comments and advice as well as his patient supervisions. It is an honor for us to have him as our supervisor. Last but not least, we would like to thank all those people who has supported and helped us with this thesis.

Lund University, June 2010

**Authors:** Patchara Boonyaprasit and Sen Yang

# Table of Contents

<b>1. Introduction.....</b>	<b>1</b>
1.1 Background.....	1
1.2 Research Questions.....	3
1.3 Purpose.....	3
1.4 Delimitations.....	3
<b>2. Theoretical framework.....</b>	<b>4</b>
2.1 Enterprise Resource Planning (ERP).....	5
2.2 Decision Support System (DSS) .....	8
2.3 ERP Software Selection Criteria for SMEs.....	9
2.4 Analytic Hierarchy Process (AHP) .....	14
2.5 Overall Theoretical Framework.....	19
<b>3. Research methodology.....</b>	<b>21</b>
3.1 Overview Methodology.....	21
3.2 Data Collection.....	21
3.2.1 Questionnaire Design.....	22
3.2.2 Interview Guide.....	23
3.3 Data Analysis.....	24
3.3.1 Questionnaire Analysis.....	24
3.3.2 Interview Analysis.....	24
3.3.3 Analytic Hierarchy Process (AHP) Method.....	25
3.4 Research Quality.....	25
3.5 Research Ethic.....	26
<b>4. Results from Data Collection and Analysis .....</b>	<b>28</b>
4.1 Data Collection from the Questionnaire.....	28
4.2 Data Analysis.....	32
4.3 Two Sample ERP Providers.....	33
4.4 Assessment and Analysis of the Data.....	34
<b>5. Discussion.....</b>	<b>38</b>
<b>6. Conclusion.....</b>	<b>41</b>
5.1 General Conclusion.....	41
5.2 Limitation.....	42
5.3 Further Research.....	42
<b>7. Appendix I.....</b>	<b>44</b>
<b>8. Appendix II.....</b>	<b>53</b>
<b>9. Appendix III.....</b>	<b>54</b>
<b>10. Appendix IV.....</b>	<b>55</b>
<b>11. References.....</b>	<b>60</b>

## List of Tables

<b>Table 2.1:</b> The criteria and sub-criteria of selecting an ERP Provider.....	14
<b>Table 2.2:</b> Scale of preference between two attributes.....	16
<b>Table 2.3:</b> a matrix example of the weight of attributes regards to the goal.....	17
<b>Table 2.4:</b> a matrix example of alternatives with respect to attribute A.....	17
<b>Table 2.5:</b> a matrix example of alternatives with respect to attribute B.....	17
<b>Table 2.6:</b> Random consistency index from 1-10.....	19
<b>Table 4.1:</b> The scales of the preference have been selected by percentage from the questionnaires.....	30
<b>Table 4.2:</b> Pair-wise comparison matrix of the main criteria.....	31
<b>Table 4.3:</b> Pair-wise comparison matrix of the sub-criteria of Vendor Credentials.....	31
<b>Table 4.4:</b> Pair-wise comparison matrix of the sub-criteria of Financing Option.....	31
<b>Table 4.5:</b> Pair-wise comparison matrix of the sub-criteria of Maintenance.....	31
<b>Table 4.6:</b> Pair-wise comparison matrix of the sub-criteria of Implementation.....	32
<b>Table 4.7:</b> Relative weights of critical criteria of SMEs.....	32
<b>Table 4.8:</b> Pair-wise comparisons of alternatives with respect to Flexibility (Flex).....	34
<b>Table 4.9:</b> Pair-wise comparisons of alternatives with respect to Functionality (Func)....	34
<b>Table 4.10:</b> Pair-wise comparisons of alternatives with respect to Vender Reputation (VR) .....	34
<b>Table 4.11:</b> Pair-wise comparisons of alternatives with respect to Market Share (MS)....	35
<b>Table 4.12:</b> Pair-wise comparisons of alternatives with respect to Demonstration of previous implementation (Demo).....	35
<b>Table 4.13:</b> Pair-wise comparisons of alternatives with respect to Software Cost (SC)....	35
<b>Table 4.14:</b> Pair-wise comparisons of alternatives with respect to Consulting and Maintenance /upgrade cost (CC).....	35
<b>Table 4.15:</b> Pair-wise comparisons of alternatives with respect to how to pay for the investment (HTP).....	35
<b>Table 4.16:</b> Pair-wise comparisons of alternatives with respect to after sale service and Training (ASS).....	35

<b>Table 4.17:</b> Pair-wise comparisons of alternatives with respect to updating and inquiry (UI).....	36
<b>Table 4.18:</b> Pair-wise comparisons of alternatives with respect to Customization (Cust).....	36
<b>Table 4.19:</b> Pair-wise comparisons of alternatives with respect to Ease of integration (Inte).....	36

## List of Figures

<b>Figure 2.1:</b> A simple AHP hierarchies.....	15
<b>Figure 2.2:</b> Scale of preference between attribute A and attribute B.....	16
<b>Figure 2.3:</b> The overall theoretical framework of our thesis.....	20
<b>Figure 4.1:</b> AHP decision model for ERP selection.....	29
<b>Figure 4.2:</b> The summary of the priorities of criteria, sub-criteria and alternative.....	37

# 1. Introduction

## 1.1 Background

Facing the complex and volatile business environment, more and more small- and medium-sized enterprises (SMEs) are seeking information techniques/package software to help them improve their market competitiveness. Since, nowadays there are many Enterprise Resource Planning (ERP) system providers in the IT market. The ERP is a powerful system, which is the integrated software for operating different perspectives of a business, such as accounting, payroll and customer relationship management. It enables all information within the organization to flow between each organization's modules. All data needs to be entered once into the system; all would be automatically link to each other (Hildreth, 2004). Businesses can benefit on this as they are able to retrieve the same data. Muscatello, et al., (2003) documented that ERP system has been found to be critical in improving customer satisfaction and also effective in reducing inventory costs, improving efficiency and increasing profitability. However, the lack of SMEs' experience in ERP, the large amount of ERP providers on the market and also the complexity of considering factors for selecting an appropriated ERP software provider for themselves become barriers for SMEs (Umble, et al., 2003; He and Li, 2009).

There are several key phenomena which indicate SMEs should adopt ERP system into their organization, the continuous growing of SMEs business on the market, SMEs also face the issue of how to use the information technology to strengthen their management and improve their efficiency (Liu, 2009). Malhotra and Temponi (2010) documented that it is necessary for small business to implement an ERP system to maintain control of their operations and to success in worldwide. Another phenomenon is that they are eager to reduce or eliminate some legacy systems within their organizations, which is time-consuming and non-cost effective in upgrading and maintenance in order to adapt themselves to current high competition in the market (Kimberling E., 2006). To adopt the ERP system into SMEs, all requirements and demands from an enterprise should be provided by an ERP Provider and a full integration is needed. These SMEs normally have

unique requirements for ERP software, to match with their business strategies and can achieve the goals of high capability, quick return on investment without any complexities (Foley, 2007). An appropriate provider for SMEs should provide the full integration and complete solution to them. The main primary reason for SMEs to implement an ERP system is to eliminate excessive and multiple legacy computer software, which are sometimes maintained and implemented by more than one software providers and would possibly take more time and investment (Smith A., 2009). Thus, ERP system is becoming more and more important to SMEs business and in order to choose the right ERP provider from various alternatives on the market, SMEs need to concern about all appropriated requirements.

Therefore, one of strategies is to use Decision Support System (DSS) to support business decision making activities to decide an appropriate ERP provider. Decision support system is an interactive computer-based system along with a human resource component that combines communication, computer, and decision technology to support the formulation and solution of unstructured problems (Jessup and Tansik, 1991). The decision maker can make decision easily as all data would be analyzed and then presented to them. It also helps decision makers to assess complex judgmental problems by integrating itself to the Analytic Hierarchy Process (AHP) which is decision support making method. An AHP methodology would be able to provide the alternative solutions. It is designed to help decision makers systematically to approach an unstructured problem by comparing each criterion through the hierarchy in order to decide on the most appropriate alternative to an organization (Tavana, et al., 1993). The right decision is usually made based on data quality and the analysis method to conclude the trend. It considers a new conjunction along with SMEs business strategies. The special value of AHP is to judge intangible criteria parallel to tangible criteria which have known measurements (Saaty, 1986).

In our thesis, we will use AHP as a decision making tool to help those SMEs who are eager to outsource their information systems to ERP providers but lack experience for



selecting one in a practical way. Furthermore, offering them a fixed approach and process to apply and follow to select an appropriate ERP provider for them.

## **1.2 Researcher Questions**

- RQ1: Which criteria these SMEs need to focus on when selecting an ERP provider?
- RQ2: How to use an AHP methodology as a method to help SMEs to select an optimal ERP provider?

## **1.3 Purpose**

The purpose of our paper is to explain and conceptualize a decision making approach for those SMEs who are eager, but hesitate to decide on how to establish an ERP system in their organization, and help them to choose an appropriate one by using the AHP method.

## **1.4 Delimitations**

Due to the limited time and our social network, it is rather impossible for us to send the questionnaire where everywhere in the world and cover all types of industry. Therefore, in this thesis we only attempt to investigate the SMEs in China who want to have or have had an ERP system in their companies. Also we do not intend to find if there are some differences between Chinese SMEs' attitudes toward to the criteria of selecting an ERP system and the SMEs' attitudes in other countries. As we mentioned before, the SMEs normally have unique requirements for the ERP software which differ from the big organizations (Foley, 2007). Thus, our research solely focuses on the requirements of SMEs instead of the big organizations and we will not investigate the different requirements between SMEs and the big organizations. An important delimitation in our thesis is that the criteria we chose can hardly include all the criteria which SMEs concern about, but based on literature, we only selected the six main criteria and ten sub-criteria which are given the most concern by these SMEs when choosing an ERP provider.

## 2. Theoretical Framework

---

*This chapter will present the main theories which are used in our thesis, and explain how these concepts related with each others. The characteristics of ERP (Enterprise Resource Planning), DSS (Decision Support System), AHP (Analytic Hierarchy Process) and the ERP selection criteria for SMEs (Small-and Medium sized Enterprises) based on literatures are explained here. At the last of this chapter, we drew a model for explaining and conceptualizing how the decision can be made to choose an appropriate ERP Provider by SMEs by combining these concepts and theories.*

---

In today's highly competitive environment, companies have to make quick and correct decisions to be able to organize huge amounts of external information and respond to dynamic and changing global markets because of increasing global competition and shorter product life cycle (Karaarslan and Gundogar, 2009). The DSS (Decision Support System) clearly offers management a powerful tool and is rapidly becoming an integral component of managerial work to deal with the uncertainties in the internal and external of organizations (Marakas, 2002; Turban and Aronson, 1998). But as we know that there are many SMEs who have not applied any of this concept and technique to their company due to lack of capital, budget, experience or even fear of using new technology, and they think it is unnecessary to use one to help them to make their decisions.

Ufuk (2009) claimed that it is a critical issue to make their decision of selecting the best-fit ERP system which meets all the business strategies and the goals of the company. However, almost all the researchers in the area of EPR agree that the possible way to fail at an ERP implementation is to choose the wrong software (Shaul, 2006). Thus, by using a decision support making approach or model to help those SMEs which are eager and hesitate to decide about establishing ERP systems in their companies is increasingly being required and requested. Nevertheless, the AHP can be very useful in involving several decision makers with different conflicting objectives to determine the priority of a set of

alternatives and the relative importance of attributes in a multiple criteria decision-making problem in order to arrive at a consensus decision (Saaty, 2000). A number of methods have been applied to ERP selection including scoring, ranking, mathematical optimization, multi-criteria decision analysis, and also AHP methodology (Wei, et al., 2005). But there is no fixed method for ERP system selection (He and Li, 2009).

We suggest that the AHP methodology could be one of the most suitable solutions for helping SMEs to make the decision regarding the criteria of choosing the appropriate ERP provider. We found that it is not a new topic using the AHP method to help companies to select an appropriate ERP provider, but the majority of the previous researches were focusing on specific areas and industries, like phone companies, Turkish manufacturing companies, textile industry, and etc. (Birdogan and Kemal, 2005; Ufuk, 2009; Siswanto and Utomo, 2008).

Most every world-wide organization has already adopted ERP, and increasingly, SMEs are finding it cost effective and a competitive necessity to follow suit (Klaus, et al., 2000). SMEs cannot afford the expenses like a large enterprise, and in most cases limitation for implement ERP system to their organizations is also relate to management capabilities. However, SMEs have been recognized as crucial contributors in the economy growth and local development of many countries, numerous new opportunities are opening for them in today's markets.

## **2.1 Enterprise Resource Planning (ERP)**

The term "Enterprise Resource Planning (ERP)" is originally derived from manufacturing resource planning (MRP II) that followed material requirements planning (MRP) (Anderegg, 2010). To understand more in the term of ERP, Davenport (1998) argues that "ERP system is commercial software which promises the seamless integration of all the information flowing through various departments of a company that can achieve the information sharing of the financial and accounting information, human resource

information, supply chain information, customer information”. In additional, Su and Yang (2009) also documented that “ERP system is designed and aim to automate the flow of material, information, and financial resources among all functions within an enterprise through different departments which is an integrated enterprise computing system, and one way to looking at ERP is as a combination of business processes and information technology”.

These comprehensive packaged and computer-based software solutions seek to integrate the complete range of a business's processes and functions which include planning, manufacturing, sales, marketing and etc., in order to manage the internal and external resources and to present a holistic view of the business from a single information and IT architecture. It is rather complex, time- and money-consuming work for implementing ERP software in-house, therefore it is desirable and highly recommended to outsource the design and implementation of the ERP software to an ERP provider who is professionally trained to built and employ these systems (Klaus, et al., 2000; Monk and Wagner, 2006).

Nowadays, ERP software as a commercial product is offered by a large range of ERP Providers that specialize in this area of the software market. Thus, the determination of ERP software selection criteria for ERP success plays an important role while organizations consider implementing an ERP system (Tsai, et al., 2009). It seems that an ERP system is becoming more popular presently although there are several criterions in order to choose an appropriated provider. The variety of SMEs’ requirements and their necessities are support our interest in further study on which criterions are concerned by SMEs. ERP providers on the market are now moving their attention toward SMEs business by offering less expensive and more flexible solutions for SMEs. The solutions those are not complicated to match their provided functionality to existing system in SMEs (Chen, 2001).

Muscatello, et al., (2003) explained that ERP providers are now steadily turning their marketing sights on small and medium-sized enterprises. Implementing an ERP system

into the SMEs, it is possible to help them to improve their business strategic and competitive capabilities (Smith, 1999; Jenson and Johnson, 1999). In the research about critical decisions for ERP integration and implementation for small business, Malhotra and Temponi (2010) augured that ERP implementation is expensive and risky for all businesses, but it is still more challenging for SMEs, which have particular characteristics. In the mean time, they argue that an ERP system, which is implemented to an organization, is complicated and difficult to evaluate value creation and economic returns, as the system integrates different components of computer software and hardware to enable information flow throughout the enterprise.

Davenport (1996) described the implementation of ERP systems as “*perhaps the world’s largest experiment in business change*” and for most organizations “*the largest change project in cost and time that they have undertaken in their history*”. Muscatello, et al., (2003) argued that if an ERP system is implemented successfully, it can bestow impressive strategic, operational and information-related benefits to these organizations, in the other way if it fails, it can often spell financial doom. Trunick (1999) describes that only 40% of all the ERP installations achieve only partial implementation and nearly one in five (20%) are scrapped as total failures. Therefore, we can say that not all of the organizations who decided to implement an ERP system are satisfied with the results (Muscatello, et al., 2003).

To implement one ERP system into an organization, total costs include both the implementation cost and long-term support or after-sell service cost, which also refers to system maintenance and upgrading cost (Babey, 2006). However, implementing an ERP system to an organization is an expensive and risky venture according to the research from Chen and Lin (2009) and Markus and Yanis (2000). Furthermore, in the recent research from Malhotra and Temponi (2010), they indicated that the ERP implementation is still an expensive project, even for small size organization. They also mentioned that many small businesses either do not have sufficient resources due to the long implementation times and high fees associated with ERP implementation, this statement

can also be referred to the research from Cragg and Zinatelli (1995) and Nah and Lau (2001).

Su and Yang (2009) discuss about countless benefits after an ERP system is implemented and merged to the core of the business organization, the expected results include: reduction of cycle time, faster transactions, better financial management, the laying of the groundwork for e-commerce, and making tacit knowledge explicit. In addition, Muscatello, et al., (2003) documented that an ERP system has been found to be critical in improving customer satisfaction and also be effective in reducing inventory costs, improving efficiency and increasing profitability.

Davenport (1998) proposed that implementing ERP systems would bring various benefits to the organization, including reduction of regular cycle time, improving the quality of information flow, rapid generation of financial information, promotion of the E-business, and assistance in development of new organizational strategies.

## **2.2 Decision Support System (DSS)**

Decision Support System (DSS) is a computer-based system, which is designed to help decision makers in each organization using organized data and knowledge technology to identify problems, and find solutions from those alternative options. The decision makers are able to use DSS to share useful information among groups of people within the same organization, and it is able to support the collaboration work to do the group decision as well (Turban, et al., 2007).

Cebi and Kahraman (2010) documented that decision making is a procedure to find the optimal choice among a set of feasible alternatives and since all decision making problems have multiple alternatives and criteria which makes it difficult to give a decision. For this reason, Analytic Hierarchical Process (AHP) is one of the techniques which can be used for solving complicated decision making problems (Cebi and Kahraman, 2010).

The DSS is an applied discipline that uses knowledge and especial theory from other disciplines (Power, 2008). Sprague and Carlson (1982) defined DSSs as “*a class of information system that draws on transaction processing systems and interacts with the other parts of the overall information system to support the decision-making activities of managers and other knowledge workers in organizations*”. Toscani, et al. (2010) argues on their research that a decision support system (DSS) is a technique which is based on statistic learning. It is able to forecast requirements and demands of users based on statistical result. The major DSS’s intention is to help users to make the best and most appropriate decision when there are various information types in complicated situations (Cebi and Kahraman, 2010). Consequently, DSS is emphasized on manipulating quantitative models, accessing and analyzing large data, and also supporting group decision making in some cases, for example, when brainstorming is required. Decision makers should be able to access the required and necessary data at anytime they want to make the decision making more effective. The data must be integrated and also organized in the consistent form that is easy to retrieve, so it becomes more useful as a resource to the decision makers (Morrison, et al., 2000).

Cebi and Kahraman (2010) explained that DSS have been widely used in current markets by managers as a specific management tool and technique since it reduces the uncertainty and risk related to complex decision making. Thus, the concept of DSS is possible to apply into decision making process for SMEs, in order to arrange brainstorming and decisions on the criterion to be concerned and the most appropriated provider to their requirement(s) and organization.

### **2.3 ERP Software Selection Criteria for SMEs**

Generally speaking, there are two separate categories of the requirement for software: functional and non-functional (Karlsson, 1997). The functional requirements are the core of the statement, describing the functions of the software system that are expected by the software users. The functional requirements typically describe the relationships between

all valid (and invalid) inputs to the software system and the similar outputs of the software system (Sen, et al., 2009). On the other hand, traditional features of a system that are not covered by its functional description have been called non-functional requirements, which are difficult to elicit, express, quantify and test (Bosch and Molin, 1999; Sen, et al., 2009). Regarding the issue of the size of the organization, according to the survey made by Bernroider and Koch (2001), indicates that when comparing with the large organization the increasing organizational flexibility, extra-organizational ties with customers, suppliers and internationality are not an issue for smaller organizations compared to costs and adaptability of the software.

McCall et al. (1977) firstly suggested eleven criteria for judging the quality of the software. Numerous researchers have since expanded and modified those characteristics into different criteria based on those eleven. Alanbay (2005) proposed that there are 15 important criterions for selecting ERP provider according to the need of organizations such as, customization, implementability, maintenance, real time changes, flexibility, user friendliness, cost, after sales support and training, integrating with other software/applications, financing options and etc. Total cost of ownership, functional fit of the ERP system, user friendliness, flexibility, vendor's reputation, service and support quality are six dimensions of criteria for selection ERP providers suggested by Karsak and Özogul (2009). Nevertheless, in ISO 9126, it categorizes the key characteristics of the software quality into six dimensions based on attributes: functionality, reliability, usability, efficiency, maintainability and portability (Liang and Lien, 2007). However, with regards to the SMEs, Bernroider and Koch (2001) claimed that the attributes of operating system independency, process improvement, market position of vendor, customer and supplier needs, internationality of software, increased organizational flexibility, guidelines from a controlling company improved innovation capabilities and good support etc. should be the criterions that SMEs need to take into account when selecting an ERP provider.

Based on the literature review, and inspired by the previous study of McCall et al. (1977), Alanbay (2005), Karsak and Özogul (2009), Liang and Lien (2007), Bernroider and Koch



(2001) and etc., also consulted with the experts who are working in the field of ERP market, there is no agreed-upon and formal procedure for choosing criteria (Laudon and Laudon, 1998; Hecht, 1997). According to our research and after organizing the criteria that addressed in prior studies and researches, we determined six main criteria and ten sub-criteria (Table 2.1) as important for consideration during the ERP software selection process for SMEs.

**Vendor credentials:** Almost all the literature on the ERP selection criteria talk about vendor credentials no matter for large company or small- and medium-sized company. There is no distinguishing between large-, medium-, and also small- sized company. Generally speaking, there are three attributes in Vendor credentials we have concluded from the previous study, which are Vendor's reputation, market share and the demonstration of previous implementation. They are the three main factors for judging the vendor credentials, which SMEs can use to inquire about the ERP providers, since reputation and market share are possible to indicate provider's performance. The demonstration of previous implementation can be used to check on the efficiency of their ERP system. *In a word, the criterion Vendor credentials indicate the fame of the ERP Provider in the market, and also can show the commitment of the vendor to the product* (Alanbay, 2005).

**Financing option:** Software cost, Consulting and Maintenance/upgrade cost, and How to pay for the investment are three sub-criteria in this dimension. To choose an appropriate provider, implementation cost is high ranking in the decision making process for SMEs, including after-sales service in case some unpredicted problem occurs, and employee's training cost to train how to use it. A survey made by Celeste, et al., (2003) shows that the annual maintenance costs approximate 25% of the initial ERP implementation costs, and upgrade costs as much as 25-33% of the initial ERP implementation. Referred to small- and medium- size Company, they might be unable to pay the vast money at once. Hence, it seems to be important for an organization on how to pay for the investment and how long they need to pay for it. *Overall, this Financing option represents the whole cost of*

*the ERP system and the way to pay for it.*

**Maintenance:** Future ERP maintenance and service needs should be considered as early as during the ERP system selection phases (Gross, 2010). The dimension maintenance concerns about the After-sale service and training as well as the Real-time change and online inquiry. The training should be provided, and also the after-sales service. Thus, users will clearly understand software's features and its capability. If without the maintenance, there would be some bad consequences like: inability to upgrade the software, business operations become frozen in time and proliferation of workarounds outside the system (Kimberling, 2010). *Clearly, this criterion indicates the services after the ERP system settle down.*

**Functionality:** No single ERP packaged software can satisfy all the firm's functionalities or special business requirements (Ehie and Madsen, 2005). Different companies ask for different system functions due to their unique requirements, which normally include Product Configuration, Distribution Requirements Planning, Quality Assurance/Management, Customer Service Management, Human Resources Management, Sales and Operations Planning, Maintenance Management, Warehouse Management, Transportation Management, Supply Chain Execution Management and etc. (Avraham, 2002; Klaus, et al., 2000; Turbide, 1999). In Cliff (2006)'s study, he mentioned that organizations are only running 50% of the functionality implemented in their enterprise resource planning system, and are paying for functions they never use, according to research published by Butler Group. *Thus, here, the functionality not only means how many functions it has but also how good the functions that the ERP system can provide.*

**Flexibility:** Which means the system, should be easy to use; the system should not be too complex in design but have a well-managed user interface. The capability to support the needs of the business over its lifetime, in order to suit the organizational culture and business strategy, even though some business strategies are changed or added is also required. Ease of use is, perhaps, more important for smaller companies, as they often do

not have adequate in-house IT personnel to help them use the application (Chaudhary, 2007). *So, the flexibility represents the degree of ease of use of the ERP system and how well the system can work along with the business over its lifetime.*

**Implementation:** An ERP system, implemented across an organization can able to affect almost all of the business processes of that organization (Malhotra and Temponi, 2010). Customization and Ease of integration are quite critical issues when implementing the ERP system in an organization. Since different organizations need different software, they need to adapt the available ERP in the market for their own use along with their previous software in their organization. Thus, the ERP modules should be integrated and provide seamless data flow among the other modules, increasing operational transparency (Loh and Koh, 2004). Furthermore, ERP should be available to exchange data with the current application. However, many SMEs either do not have sufficient resources or are not willing to commit resources due to the long implementation times and difficulties associated with ERP implementation (Cragg and Zinatelli, 1995; Nah and Lau, 2001). *Implementation describes how the new ERP system can be adapted and integrated with your current system as well as the time consuming during the implementation process, and it can customize the unique system in accordance with your business strategy.*

**Table 2.1:** The criteria and sub-criteria of selecting an ERP provider

<b>Criteria</b>	<b>Sub-criteria</b>
<b>Non-functional requirements</b>	
Vendor credentials (VC)	Vendor reputation (VR)
	Market share (MS)
	Demonstrations of previous implementation (Demo)
Financing option (FO)	Software cost (SC)
	Consulting and Maintenance/upgrade cost (CC)
	How to pay for the investment (time and way) (HTP)
Maintenance (Main)	After sale service and training (ASS)
	Updating and Inquires (UI)
<b>Functional requirements</b>	
Functionality (Func)	
Flexibility (Flex)	
Implementation (Impl)	Customization (CUST)
	Ease of integration (time consuming and effect of integration) (Inte)

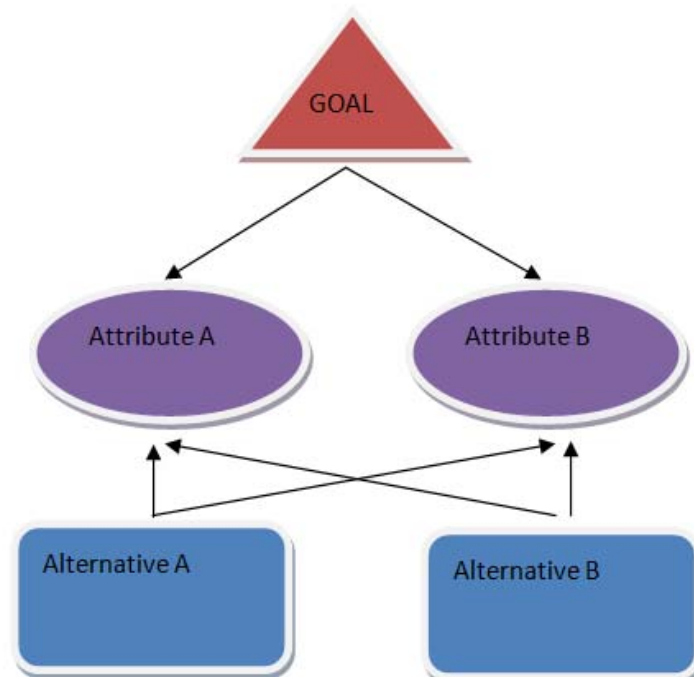
However, the criteria and sub-criteria of selecting an ERP provider we generated and presented above can be applied into the AHP method in our study, and built these criteria as the various attributes regard to the goal of selecting the optimal ERP provider for SMEs.

## 2.4 Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process is a structured technique for dealing with complex decisions and it provides a fundamental scale of relative magnitudes expressed in dominance units to represent judgments in the form of paired comparisons (Saaty, 1990). Based on mathematics and human psychology, it was developed by Saaty in the 1970s

and has been extensively studied and refined since then (Bhushan and Kanwal, 2004). Nevertheless, here, in our research, based on the literature review and practical investment we suggested that the AHP should be one of the most valid approaches to help those SMEs to make their decisions when choosing their ERP Providers in the mass of information technology market. Decision makers of the company can then select the right ERP system to fit their business processes and strategy instead of adapting to fit the ERP software.

There are four steps in AHP method, firstly is *Decomposing*. In this step, the problem is decomposed into attributes (which are grouped on different levels to form a chain of hierarchy, simply show in Figure 2.2). Each attribute is further decomposed into Sub-attributes/Alternatives until the lowest level of the hierarchy (Zahedi, 1986; Saaty, 2000).



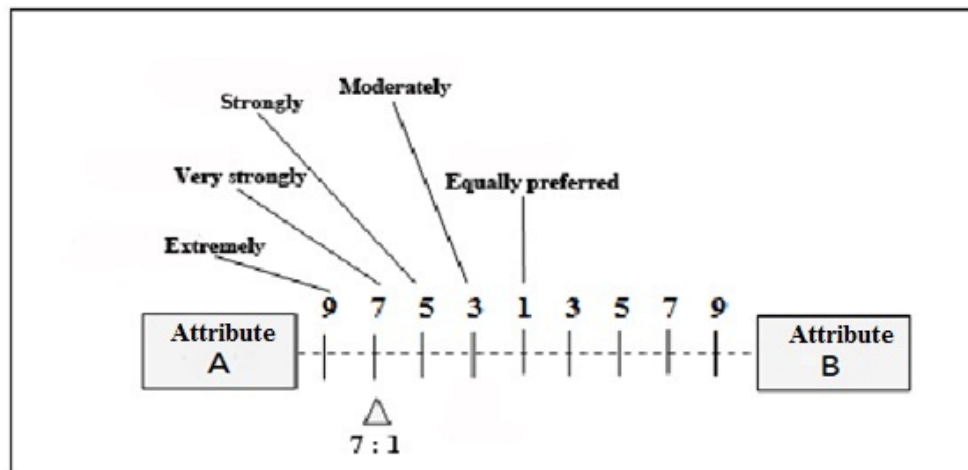
**Figure 2.1:** A simple AHP hierarchies

The second step is called *Weighing*. This step involves giving the scale of preference for each two of the attributes and sub-attributes by using a rating scale (Table 2.2).

**Table 2.2:** Scale of preference between two attributes (Saaty, 2000)

Preference weights/level of importance	Definition	Explanation
1	Equally preferred	Two activities contribute equally to the objective
3	Moderately	Experience and judgment slightly favour one activity over another
5	Strongly	Experience and judgment strongly or essentially favour one activity over another
7	Very strongly	An activity is strongly favoured over another and its dominance demonstrated in practice
9	Extremely	The evidence favouring one activity over another is of the highest degree possible of affirmation
2, 4, 6, 8	Intermediate values	Used to represent compromise between the Preferences listed above
Reciprocals	Reciprocals for inverse comparison	

How to get the weight of each attribute? The following is a way to calculate the weight in the *Evaluating* step. An assumption is that if the decision maker considers the importance of attribute “A” as Very Strongly than attribute “B”, it is rated at 7. On the contrary, attribute “B” must be much less important than “A”, so it is valued at 1/7 (Figure 2.3). These paired comparisons are carried out for all factors to be considered.

**Figure 2.2:** Scale of preference between attribute A and attribute B

Next, we sum the numbers of each column and make each of the scale of preference divided by the sum of its column. You have to add up the result numbers of lines and divide it by the matrix of order  $n$ . Then you get the weight of each attribute—PV (Priority

Vector), see Table 2.3, the figure between brackets shows the weight of each attribute.

**Table 2.3:** a matrix example of the weight of attributes regards to the goal

	<b>Attribute A</b>	<b>Attribute B</b>	<b>PV (Priority Vector)</b>
<b>Attribute A</b>	1 (0.875)	7 (0.875)	0.875
<b>Attribute B</b>	1/7 (0.125)	1 (0.125)	0.125
	1.143	8	

About the weight of each attribute regards to the alternative, we use the same way to calculate the PV for every alternatives (Table 2.4 and Table 2.5).

**Table 2.4:** a matrix example of alternatives with respect to attribute A

	<b>Alternative A</b>	<b>Alternative B</b>	<b>PV (Priority Vector)</b>
<b>Alternative A</b>	1(0.2)	1/4(0.2)	0.2
<b>Alternative B</b>	4(0.8)	1(0.8)	0.8
	5	1.25	

**Table 2.5:** a matrix example of alternatives with respect to attribute B

	<b>Alternative A</b>	<b>Alternative B</b>	<b>PV (Priority Vector)</b>
<b>Alternative A</b>	1(0.33)	1/2(0.33)	0.33
<b>Alternative B</b>	2(0.67)	1(0.67)	0.67
	3	1.5	

We now calculate now the overall priority for each alternative solution by the formula:

*The weight of the attribute regards to the goal\* the weight of the attribute regards to alternatives=priority*

The overall priority of one alternative solution is the sum of each priority of the attributes for this alternative.

So, the alternative A's overall priority for the goal is:

$$0.875*0.2+0.125*0.33=0.217;$$

The alternative B's overall priority is:

$$0.875*0.8+0.125*0.67=0.783;$$

The next step is '*Selecting phase*', from the step 3 we can get the overall priority for each alternative, and the best choice is the alternative which has the largest overall priority value.

The final stage is to measure how consistent the judgments have been relative to large samples of purely random judgments (Coyle, 2004). Suggested by Saaty that the consistency index CI (consistency index) =  $(\lambda_{\max} - n) / (n - 1)$  to test the consistency of the intuitive judgment. However, he modified this approach in 2000 by introducing the term CR (consistency ratio) which is calculated in the way as following:

Step 1: Calculate the biggest eigenvector ( $\lambda_{\max}$ ). The formula is to multiply the sum of each row by the PV of each column.

Step 2: Compute the CI for each matrix of order n by the formula:

$$CI = (\lambda_{\max} - n) / (n - 1)$$

Step 3: The CR is then calculated using the formula:

$$CR = CI / RCI$$

The random consistency index (RCI) is obtained from a large number of simulations runs and varies depending upon the order of matrix (Kannan, 2008). Table 2.6 shows the value of the RCI for matrices of order 1-10 obtained by approximating random indices using a sample size of 500 (Saaty, 2000).



**Table 2.6:** Random consistency index from 1-10 (Saaty, 2000)

<b>n</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

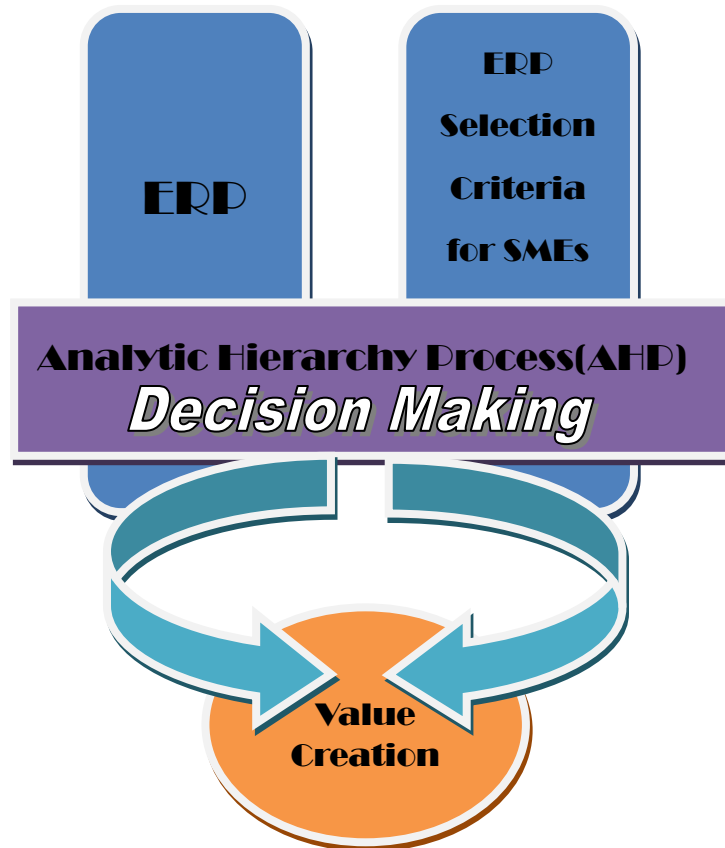
If the value of CR is equal to, or less than 0.1, it implies that the evaluation within the matrix is acceptable. If CR is more than 0.1, the inconsistency of judgments within that matrix has occurred and the evaluation process should therefore be reviewed, reconsidered and improved (Crowe, et al., 1998).

## 2.5 Overall Theoretical Framework

Combined the theories which are presented above in the section of theory framework, we created the holistic theoretical framework that runs through our paper (Figure 2.4). There is no doubt that using ERP software in an appropriate way can help organizations to improve their performances and working efficiencies under the condition that you have chosen the right ERP Providers according to the right selection criteria, which the organization concerns and the provider can fulfill. Thus, using a decision support method to help these SMEs to make their decisions in a set way is mainly the objective of our study. The following is the argument for the choices of our theories:

It is definitely necessary to understand the definition, characteristic, background and current phenomena of the ERP and its market once you want to do research on that. On the other hand, being a SME who is eager but hesitate to implement the ERP system, they have to know about how to achieve the choices which are available and best-fit for them. For this reason, the ERP selection criteria for SMEs become a crucial fact for them to select an appropriate ERP Provider, because implementing an ERP system in these SMEs is a significant for them and they cannot afford the failure of the implementation. Therefore, a scientific approach might help them to choose the best-fit ERP Provider to some extent, and make the rate of failure lower though unavoidable. AHP is a structured quantitative technique for dealing with complex decisions based on mathematics and human psychology, which is suggested by many scholars when making decisions. By

adding AHP method into the framework, we are introducing a systematic approach of making decision for dealing with the problem of choosing the optimal ERP Provider by SMEs.



**Figure 2.3:** The overall theoretical framework of our thesis

As a result, the framework above was created for explaining and conceptualizing how the decision of choosing an ERP Provider by SMEs comes out by combining the theories of ERP, the selection criteria for SMEs and the AHP decision making method.

---

## 3. Research Methodology

---

*In this chapter we will introduce the research methods we are using in our thesis, for example, how we chose and motivate methods for data collection and data analysis. Moreover, we will discuss and present how we achieve good scientific quality in our thesis, and also how we deal with the ethic issues when doing research.*

---

### 3.1 Overview Methodology

A broad literature review was conducted at the very beginning. The majority of the articles we read were found in the ELIN database of Lund University by searching the keywords “AHP”, “ERP”, “SMEs” and “ERP selection criteria”. The previous study in the course “Decision Support Systems” (DSS) inspired us to use the AHP method in our thesis. In order to verify whether or not our approach could function in practice, two commercial ERP providers on the current ERP market will be assessed by our group in order to associate to the AHP method as two alternatives for SMEs. The assessment will be based on website and our personal judgments. Regarding the selection of the two sample ERP Providers A and B, we applied the top two ERP providers from our sampling organizations. In the questionnaire, one question is about ERP system’s brand(s) which is currently in use. Then, the two ERP providers which are being used most by our responders are selected and applied as the sample of ERP Provider A and ERP Provider B in our thesis. This study employed a quantitative survey and followed by a qualitative interview which aims to confirm the data and information from the survey.

### 3.2 Data Collection

After applying the particular qualitative and quantitative approaches to inquiry, the next step is collection of data by asking open-ended research questions to gather the multiple forms of data to answer these human problems and questions, also group them into different categories (Creswell, 2007). However, different research approaches have different ways, groups to collect, record and store. Using data-collection techniques

allows us to collect information about our objects and purpose of study systematically.

In our research, the most important thing was to learn and understand the current state of the SMEs to see what they are suffering when they plan to establish an ERP system within their enterprises. However, the best way to learn it is from the IS managers and employees in several different SMEs. Since in our research, we needed plenty of information from the IS managers and employees in different enterprises, and it was impossible to have face to face interviews or telephone interviews with all of them, and questionnaire was an optimal option for us to collect the numerous data which we wanted. Hence we decided to use questionnaire as one of our main data collection methods in our research.

### **3.2.1 Questionnaire Design**

#### **The questionnaire**

Our questionnaire contains three parts, background information, criteria's introduction, and criteria's comparisons. The questionnaire starts with the background information about the responders. If someone has not participated nor has any experience in the ERP implementation, the questionnaire we received was not being used in our research. The part of criteria's introduction briefly introduces the motivation of our questions and comparisons between different attributes we asked in the next section, moreover, we mentioned and discussed about why these criteria were selected in detail in the "ERP Software Selection Criteria for SMEs" part. The questions in the criteria's comparisons part concerned the responders' preferences on different criteria which might influence the selection of an ERP into their organizations, and these criteria we selected mainly based on the academic study which we presented in the previous chapter. Additionally, the questionnaire was translated into Chinese to address and facilitate the target population.

#### **Population and Sample of Respondents**

Questionnaires were sent to relevant IT managers and employees who are responsible for management and maintenance of the information system of SMEs in China. The SMEs in our thesis were classified by using Provisional Regulations on the standards for SMEs,

which is managing the number of employees and turnovers within organization. This regulation has been issued by the Chinese agencies of Economic and Trade Commission, State Development Planning Commission and Ministry of Finance. We applied simple random sampling as part of our methods when selecting the respondents who registered their companies on the website “China SME online” (<http://english.sme.gov.cn/index.htm>). The other part of our sample respondents were selected through the social relations we have. Nevertheless, to ensure the relevance for our survey the background information in the questionnaire ensured the validity and reliability of their responses.

### **3.2.2 Interview Guide**

However, all data collection techniques have their own disadvantages when applying them in a research. Therefore, using the combination of the data collection techniques becomes crucial, and they can complement each other, even reduce the chance of bias and give a more comprehensive understanding of the issue under research (Creswell, 2007). Kvale and Brinkmann (2008) documented in their research, that interviewing is one of the methods of doing strong and valuable research where the researcher can get rich and detailed answers. Interview technique allows us to clarify ambiguous answers and seek follow-up information from our questionnaire.

To corroborate the answers from the questionnaires and to extract more information directly during the conversations, one telephone interview with the IS manager who responded to our questionnaire has been conducted after we received the questionnaire. The interview went into details of the criteria we mentioned in the questionnaire, and it enables us to understand the findings from the questionnaire in a better way. However, due to the limited time and the difficulty of getting an interview with the company in China since we are now in Sweden, we only conducted one telephone interview with one of our questionnaire respondents. See Appendix II for the detail, and see the interview transcript in Appendix III.

### **3.3 Data Analysis**

Analyzing collected data needs specific strategies and techniques in order to produce the high-quality analysis (Yin, 2009). In our research, qualitative and quantitative methods were both utilized. Techniques and strategies were applied to analysis the quantitative survey and the qualitative interviews. Furthermore, the results we obtained from the survey and interview were employed and analyzed by the AHP method.

#### **3.3.1 Questionnaire Analysis**

The data we received from the questionnaires were analyzed by using the statistic tool known as SPSS package (Statistical Package for the Social Sciences). The data were recorded in SPSS, and by using the function of “frequencies” in SPSS we acquired the frequency tables for each variable (preference weights). The aim was to choose the highest frequency of the preference weight for each comparison which had been chosen by the associated IS employees in the questionnaire. Therefore, we are able to know the preference of the criteria they focus on when selecting an ERP provider.

#### **3.3.2 Interview Analysis**

Since in our research only one telephone interview was employed, this makes our interview analysis pretty simple. We did not use the technique of coding the data, nor combining the codes into broader categories or themes, but we transcribed the oral language to written language. However, the procedure of transcription from oral to written language could influence the reliability, validity and ethics of the transcription in a bad way regarding the difference between natural oral language and written text (Kvale and Brinkmann, 2008). So we did it very carefully and checked it several times. After the transcription was done, we analyzed it for condensation and interpretation of the meaning of the interview’s data in order to support the results from the questionnaire.

### **3.3.3 Analytic Hierarchy Process (AHP) Method**

In our research, we suggested that the AHP should be one of the most valid approaches to help those SMEs to make their decisions when choosing their ERP providers in the fuzzy information technology market. After acquiring the data we needed for the AHP method from the survey and the interview, we applied the AHP method in our thesis to construct the fixed approach to help the SMEs to make their decision of choosing the optimal ERP provider.

Firstly, following the procedure of the AHP method we mentioned in the previous part, we calculated the relative weights of critical criteria regard to SMEs. Secondly, two sample ERP providers were provided as the alternatives for SMEs, and the assessment of the two providers were analyzed by presenting in the twelve tables of pair-wise comparison of alternatives with respect to different criteria. Finally, we acquired the overall priority for each ERP providers.

### **3.4 Research Quality**

Good scientific quality partly means good validity and reliability for measuring the trustworthiness (Seale, 1999). Norris (1997) claimed that one practical way to take the validity into account is to focus on error and bias, which there is no paradigm to eliminate. However, it is not possible to construct rules for judging the validity of particular studies or domains of inquiry. Kvale and Brinkman (2008) is also explains the concept of the validity, namely, the validity of the theoretical presuppositions of the study, the validity in the design and methods used, the trustworthiness of the reporting and the translation process in transcribing, and the validation of the findings and results.

Since we did a telephone interview with an information system manager, the transcript of the interview and the interpretation of the interview were provided to the interviewee to confirm the information he provided. The purpose was that if our interpretations are acceptable by the interviewee, the reliability and the credibility of our findings are

increased. Furthermore, focusing on social processes can keep our research honest, fair and with good quality.

To improve the quality of the interview, the list of questions has been sent to the interviewee one week before the appointment. So, he had time to prepare productive answers for our research. We checked and refined the list of questions many times to ensure that it is in a good structure, gentle, and easy to understand for the interviewee. We interviewed an information system manager of SME in China which has adopted ERP system in his organization, and he has various experiences and knowledge of ERP implementation. Furthermore, our interviewee is an expert in the ERP area, and his organization is the right target group for our research. The provided answers are significant and also refer to our research questions. Moreover, before our questionnaire was sent, questionnaire was reviewed in advance by quantitative study professor Chen and our supervisor, and the survey sample we selected is very scientific. Therefore, these ensured the high level of validity and reliability of our questionnaire.

Kvale (1996) argues that a good interviewer is an expert in the topic of the interview. We read many articles which relate to criterion for choosing an appropriate ERP provider before forming the questions for both the interview and the questionnaire. Therefore, the questions in our interview and questionnaire are accurate and their answers are sufficient for our research. Furthermore, regards to the language we used in this research which were proofed by a native English speaker who are studying in Lund University, thus, the quality of the language in this thesis were approved.

### **3.5 Research Ethic**

Lapin (2009) claimed that the researcher should concentrate on the obligation in order to produce reliable knowledge, to maintain the public nature of research and to respect the rights of research subjects. To ask for personal data and opinion, researcher must give the necessary and clear information to participants about the research's purpose and objective.



Then, they can decide whether to participate or not (Lapin, 2009). Israel and Hay (2006) mention the importance to care about ethics, in which they believe that ethical behaviour could help gaining trust from the societies and could ensure achieving integrity of research.

In our research, ethical issues have been considered in all stages. The participants of our research in interview and survey have been well informed of the background, purpose, motivation, and methods of our research. E-mail addresses and telephone numbers of the authors were provided in the first page of the questionnaire for further information about our research. All the participants took part in the research with no pressure or influence from others. We have adhered to the highest values and standards of ethics, which includes truth, accuracy, honesty in disseminated information and publication, and reliability.

In general, the research combines ethical and moral methods in all stage of research in order to make the research work more professional and to balance the costs with benefits as well as risks and opportunities. Moreover, all contributions and participants' personal information will be made anonymous if it is necessary.

---

## 4. Results from Data Collection and Analysis

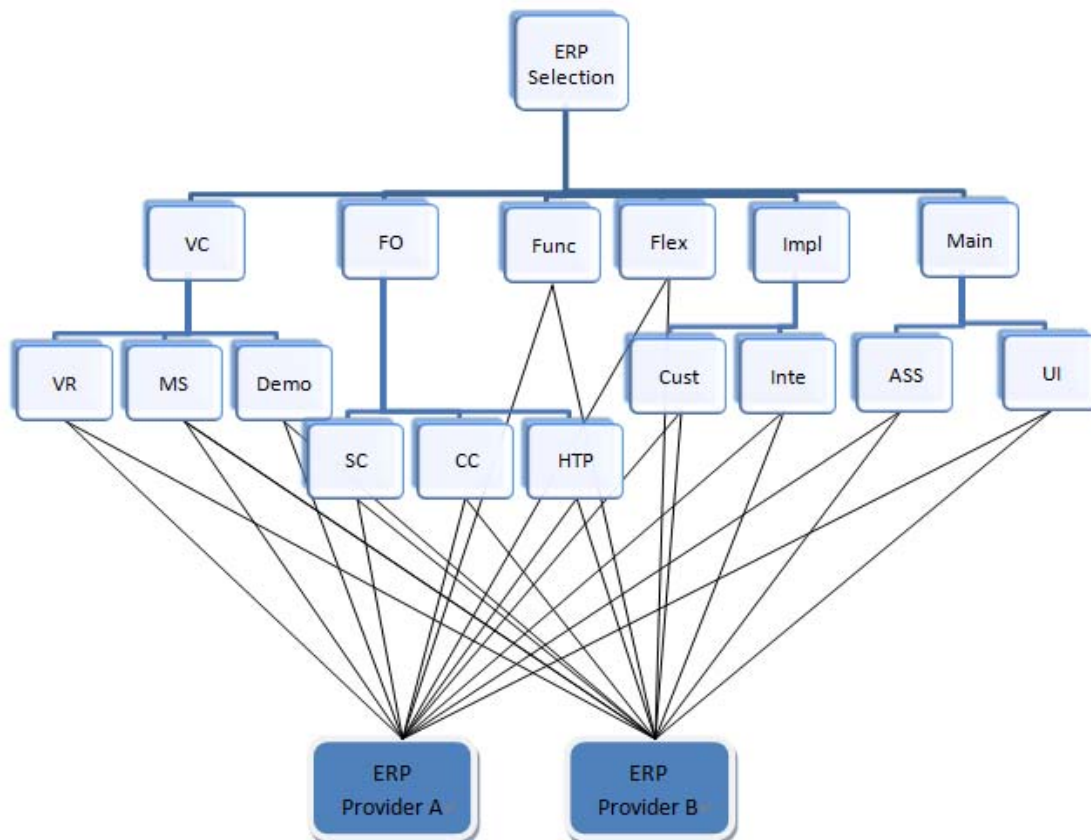
---

*The summery data which we got from the questionnaires and interviews will be presented in this chapter. By applying the method of AHP, all the data we collected will be analyzed after the data collection process. The result from the data analysis shows that the Implementation (Impl) has the highest weight (0.3173). It shows that our participated SMEs are concerns on Implementation more than the others criterion. Two sample companies are given at the last of this chapter in order to give an example for accomplishing the AHP method.*

---

### 4.1 Data Collection from the Questionnaire

Unfortunately, as we mentioned before, there are many SMEs desiring to implement an ERP system in their organization that are not prepared to decide how to establish an ERP systems in their organization due to the lack of knowledge of ERP and the complexity of considering factors for selecting the appropriate ERP software. All of these SMEs would benefit from a set method and an AHP model (Figure 4.1) for decision-making to determine which ERP Provider is the best-fit for them. On the other hand, the ERP Providers who want to entry in to this SMEs market could benefit from this study since they will learn about the criteria for selecting an ERP Provider by these SMEs, in order to assess themselves whether or not it is feasible for them to provide ERP services for SMEs.



**Figure 4.1:** AHP decision model for ERP selection

The questionnaire which was sent to the sample SMEs consisted of 27 questions. A total of 73 questionnaires have been sent to small/medium size organizations in China and 44 valid returns have been received. This corresponds to a 56 percent return quota. The majority responders' enterprises (79%) are currently using ERP system. The data was analyzed by using SPSS package. According to the results from the questionnaires (Table 4.1), there are 23 Pair-wise comparisons in our research, and the number in bold is the highest frequency (in percentage) of the scale which have been chosen by the associated IS employees in the questionnaire.

**Table 4.1:** The scales of the preference have been selected by percentage from the questionnaires.

Criteria	9	8	7	6	5	4	3	2	1	1/2	1/3	1/4	1/5	1/6	1/7	1/8	1/9
Vendor Credentials VS Financing Option	0	0	0	0	4.9	7.3	7.3	7.3	7.3	2.4	<b>41.5</b>	12.2	9.8	0	0	0	0
Vendor Credentials VS Functionality	0	2.4	0	2.4	0	2.4	4.9	4.9	12.2	4.9	<b>39</b>	12.2	9.8	2.4	0	2.4	0
Vendor Credentials VS Flexibility	0	2.4	4.9	4.9	4.9	4.9	4.9	4.9	0	0	17.1	<b>31.7</b>	9.8	4.9	12.2	2.4	0
Vendor Credentials VS Implementation	0	0	0	2.4	4.9	7.3	2.4	2.4	4.9	7.3	4.9	14.6	<b>31.7</b>	7.3	4.9	2.4	2.4
Vendor Credentials VS Maintenance	0	2.4	0	7.3	4.9	0	4.9	4.9	7.3	<b>31.7</b>	9.8	9.8	9.8	2.4	2.4	2.4	0
Financing Option VS Functionality	0	2.4	2.4	0	2.4	2.4	<b>43.9</b>	12.2	9.7	0	0	4.9	12.2	4.9	0	2.4	0
Financing Option VS Flexibility	0	0	0	2.4	2.4	9.8	2.4	12.2	4.9	4.9	12.2	<b>34.1</b>	14.6	0	0	0	0
Financing Option VS Implementation	0	0	0	4.9	0	2.4	12.2	12.2	9.7	7.3	12.2	7.3	<b>29.3</b>	2.4	0	0	0
Financing Option VS Maintenance	0	0	0	0	0	4.9	12.2	14.6	<b>36.6</b>	12.2	9.8	4.9	2.4	0	0	0	2.4
Functionality VS Implementation	0	2.4	0	2.4	2.4	7.3	4.9	12.2	4.9	12.2	<b>19.5</b>	22	9.8	0	0	0	0
Functionality VS Maintenance	0	0	0	12.2	2.4	4.9	<b>31.7</b>	17.1	4.8	9.8	0	7.3	2.4	2.4	0	4.9	0
Functionality VS Flexibility	0	7.3	0	2.4	7.3	7.3	9.8	4.9	7.3	<b>34.1</b>	4.9	14.6	0	0	0	0	0
Implementation VS Maintenance	2.4	2.4	2.4	2.4	2.4	19.5	<b>26.8</b>	14.6	14.6	2.4	7.3	2.4	0	0	0	0	0
Implementation VS Flexibility	0	4.9	2.4	0	4.9	0	12.2	14.6	<b>31.7</b>	2.4	14.6	7.3	2.4	2.4	0	0	0
Flexibility VS Maintenance	0	2.4	2.4	4.9	9.8	12.2	<b>34.1</b>	9.8	2.4	2.4	0	4.9	7.3	2.4	0	4.9	0
Vendor Reputation VS Market Share	0	0	2.4	0	0	0	9.8	9.8	17.1	0	9.8	12.2	<b>26.8</b>	7.3	4.9	0	0
Vendor Reputation VS Demonstrations of previous implementation	0	0	0	0	0	0	7.3	9.8	9.7	7.3	22	12.2	<b>24.4</b>	2.4	0	4.9	0
Demonstrations of previous implementation VS Market Share	0	0	0	2.4	4.9	7.3	4.9	12.2	14.6	4.9	<b>24.4</b>	2.4	12.2	7.3	2.4	0	0
Software Cost VS Consulting and Maintenance/upgrade cost	0	0	0	0	2.4	7.3	9.8	14.6	<b>43.9</b>	2.4	4.9	9.8	4.9	0	0	0	0
Software Cost VS How to pay for the investment(time and way)	0	4.9	14.6	7.3	<b>36.6</b>	2.4	14.6	12.2	7.3	0	0	0	0	0	0	0	0
Consulting and Maintenance/upgrade cost VS How to pay for the investment(time and way)	0	7.3	12.2	4.9	<b>31.7</b>	24.4	9.8	2.4	7.3	0	0	0	0	0	0	0	0
Customization VS Ease of integration(time consuming and effect of integration)	0	0	0	2.4	9.8	12.2	9.8	9.8	9.8	12.2	<b>26.8</b>	7.3	0	0	0	0	0
After sale service and training VS Updating and Inquires	2.4	0	2.4	0	7.3	14.6	<b>29.3</b>	9.8	17.1	7.3	9.8	0	0	0	0	0	0

Furthermore, we drew the Pair-wise comparison matrix of the six main criteria, and the sub-criteria of the Vendor Credentials, Financing Option, Maintenance as well as Implementation (Table 4.2 to Table 4.6) as follow:

**Table 4.2:** Pair-wise comparison matrix of the main criteria

	<b>VC</b>	<b>FO</b>	<b>Func</b>	<b>Flex</b>	<b>Impl</b>	<b>Main</b>
<b>VC</b>	1	1/3	1/3	1/4	1/5	1/2
<b>FO</b>	3	1	3	1/4	1/5	1
<b>Func</b>	3	1/3	1	1/2	1/3	3
<b>Flex</b>	4	4	2	1	1	3
<b>Impl</b>	5	5	3	1	1	3
<b>Main</b>	2	1	1/3	1/3	1/3	1

**Table 4.3:** Pair-wise comparison matrix of the sub-criteria of Vendor Credentials

<b>VC</b>	<b>VR</b>	<b>MS</b>	<b>Demo</b>
<b>VR</b>	1	1/5	1/5
<b>MS</b>	5	1	3
<b>Demo</b>	5	1/3	1

**Table 4.4:** Pair-wise comparison matrix of the sub-criteria of Financing Option

<b>FO</b>	<b>SC</b>	<b>CC</b>	<b>HTP</b>
<b>SC</b>	1	1	5
<b>CC</b>	1	1	5
<b>HTP</b>	1/5	1/5	1

**Table 4.5:** Pair-wise comparison matrix of the sub-criteria of Maintenance

<b>Main</b>	<b>ASS</b>	<b>UI</b>
<b>ASS</b>	1	3
<b>UI</b>	1/3	1

**Table 4.6:** Pair-wise comparison matrix of the sub-criteria of Implementation

<b>Impl</b>	<b>Cust</b>	<b>Inte</b>
<b>Cust</b>	1	1/3
<b>Inte</b>	3	1

## 4.2 Data Analysis

As a result, the relative weights of each criteria and sub-criteria were analyzed based on AHP method, which is shown in Table 4.7. As we can see from the Table 4.7, the Implementation (Impl) has the highest weight (0.3173) which represents these SMEs value Implementation most among others. The second highest one is Flexibility (Flex), which we will go into detail in the discussion part.

**Table 4.7:** Relative weights of critical criteria of SMEs

<b>Criteria</b>	<b>Relative weight using AHP</b>	<b>Sub-criteria</b>	<b>Relative weight using AHP</b>
<b>VC</b>	0.0504	VR	0.0897
		MS	0.6070
		Demo	0.3033
<b>FO</b>	0.1316	SC	0.4545
		CC	0.4545
		HTP	0.0909
<b>Func</b>	0.1364		
<b>Impl</b>	0.3173	Cust	0.25
		Inte	0.75
<b>Flex</b>	0.2765		
<b>Main</b>	0.0878	ASS	0.75
		UI	0.25
<b>CR(Consistency Ratio)=0.09&lt;0.1, thus, accept the pair-wise comparison matrix</b>			

After assigning the weights to each criterion, we evaluated and compared two ERP alternatives: ERP Provider A and B which are all commercial ERP vendors in the current ERP market.

### 4.3 Two Sample ERP Providers

In our thesis, the two sample alternative providers would be mentioned and also applied to our questionnaire's results to see which sample ERP Provider is the best-fit for SMEs. The following are the basic background of these two sample ERP provider A and ERP provider B which have been mentioned the most in the questionnaire by the responders. However, if there are three or even more alternatives, this method still can be applied to select the optimal one. The only reason why we chose two alternatives is to facilitate the calculation process.

#### Sample:

**ERP provider A:** Its ERP system is providing a deep set of features which cover most organizations' requirements in the current market. Organizations are able to customize each feature by themselves, which are pretty flexible, as well as request some help from the provider. Its ERP system is very fast, in order to process organization's transaction, they would get the result within an hour for more than 300,000 transactions. The price is approximately 60,000 Euros to 90,000 Euros for the ERP system which also depends on how much of the function is needed and 110,000 Euros for implementation including users' training, consultant and after sale support for 6 months. The implementation period will be taking approximately 2-3 months.

**ERP provider B:** Its ERP system is providing lot of features to organizations. There are some minor missing features but overall its features are able to answer what organizations need. Each feature is possible to customize depends on organizations' requirements and their business objective but they are not able to manage by themselves, technical support from provider are required, which is free of charge for one year after implementation and

the cost start from 2,000 Euros depend on organizations' needs. The price is approximately 30,000 Euros to 80,000 Euros for ERP system, depending on the required features. For implementation, internal training, system consultant, the cost is 70,000 Euros and free for after sale support for 18 months. The implementation period takes around 3-4 months depending on how many features are required. This provider has a highest market share in the last year compare to other providers who sell the same type of system.

#### 4.4 Assessment and Analysis of the Data

We have assessed the ERP provider data as mentioned in the previous section, which is based on the twelve main-criteria and sub-criteria in total. They are presented in twelve pair wise comparison of alternatives with respect to different criteria as the following table (Table 4.8 to Table 4.19).

**Table 4.8:** Pair-wise comparisons of alternatives with respect to Flexibility (Flex)

	ERP provider A	ERP provider B	Relative Weight
ERP provider A	1	6	0.8571
ERP provider B	1/6	1	0.1429

**Table 4.9:** Pair-wise comparisons of alternatives with respect to Functionality (Func)

	ERP provider A	ERP provider B	Relative Weight
ERP provider A	1	5	0.8333
ERP provider B	1/5	1	0.1667

**Table 4.10:** Pair-wise comparisons of alternatives with respect to Vender Reputation (VR)

	ERP provider A	ERP provider B	Relative Weight
ERP provider A	1	1/3	0.250
ERP provider B	3	1	0.750



**Table 4.11:** Pair-wise comparisons of alternatives with respect to Market Share (MS)

	ERP provider A	ERP provider B	Relative Weight
ERP provider A	1	1/3	0.250
ERP provider B	3	1	0.750

**Table 4.12:** Pair-wise comparisons of alternatives with respect to Demonstration of previous implementation (Demo)

	ERP provider A	ERP provider B	Relative Weight
ERP provider A	1	1	0.500
ERP provider B	1	1	0.500

**Table 4.13:** Pair-wise comparisons of alternatives with respect to Software Cost (SC)

	ERP provider A	ERP provider B	Relative Weight
ERP provider A	1	1/7	0.125
ERP provider B	7	1	0.875

**Table 4.14:** Pair-wise comparisons of alternatives with respect to Consulting and Maintenance /upgrade cost (CC)

	ERP provider A	ERP provider B	Relative Weight
ERP provider A	1	1/4	0.200
ERP provider B	4	1	0.800

**Table 4.15:** Pair-wise comparisons of alternatives with respect to how to pay for the investment (HTP)

	ERP provider A	ERP provider B	Relative Weight
ERP provider A	1	1/3	0.250
ERP provider B	3	1	0.750

**Table 4.16:** Pair-wise comparisons of alternatives with respect to after sale service and Training (ASS)

	ERP provider A	ERP provider B	Relative Weight
ERP provider A	1	1/5	0.1667
ERP provider B	5	1	0.8333

**Table 4.17:** Pair-wise comparisons of alternatives with respect to updating and inquiry (UI)

	ERP provider A	ERP provider B	Relative Weight
ERP provider A	1	4	0.800
ERP provider B	1/4	1	0.200

**Table 4.18:** Pair-wise comparisons of alternatives with respect to Customization (Cust)

	ERP provider A	ERP provider B	Relative Weight
ERP provider A	1	5	0.8333
ERP provider B	1/5	1	0.1667

**Table 4.19:** Pair-wise comparisons of alternatives with respect to Ease of integration (Inte)

	ERP provider A	ERP provider B	Relative Weight
ERP provider A	1	6	0.8571
ERP provider B	1/6	1	0.1429

By following the procedure of AHP method, we received the overall priority for each ERP Providers A and B. According to the calculation in Appendix 3, the overall priority of ERP Provider A for SMEs is 0.688 while the overall priority of ERP Provider B is 0.312.

In light of this result, we can draw the conclusion that ERP Provider A is selected to provide their service for SMEs. Furthermore, the  $CR=0.09 < 0.1$ , it illustrates our evaluation is acceptable according to Saaty (2000)'s theory. The summary of the priorities are shown in the Figure 4.2.

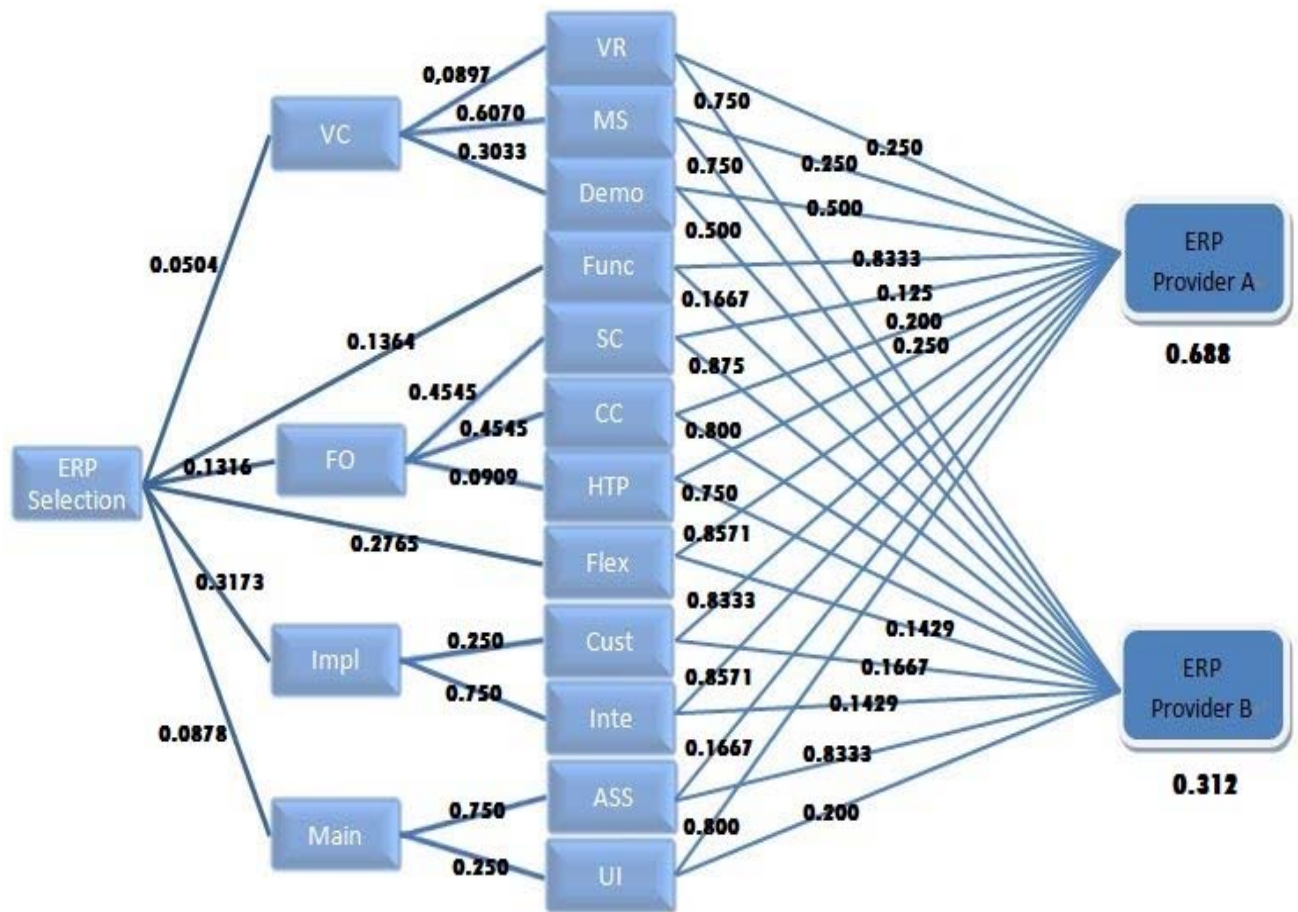


Figure 4.2: The summary of the priorities of criteria, sub-criteria and alternatives

## 5. Discussion

---

*In this chapter we will discuss the results from data collection and data analysis. To see why these SMEs think the criteria of Implementation and Flexibility are the two most important issues when choosing an ERP Provider. Meanwhile, for the ERP Providers, we believe that they could improve themselves in the six main criteria we mentioned in our thesis in order to expand their market of SMEs.*

---

In order to offer their product to customer(s), providers in the market should develop a product which is possible to match customer's requirements and also help them to achieve their business goal. To be success, they should be different from competitors in the same field of business. In the meantime, it would be helpful for customers to select the right provider in accordance with their needs. As a result, customers can clearly see each provider's background which would be easier for them to effectively identify characteristics and benefits for the right provider chosen.

As we have mentioned earlier in our study, there are six main- and ten sub-criteria for selecting best-fit ERP providers. After the data collection and analysis, by using AHP method, we calculated the relative weights of each criteria and sub-criteria (Table 4.7) which represent the priorities of them (the bigger the number equals to more priority): Vendor credentials (0.0504), Financing option (0.1316), Maintenance (0.0878), Functionality (0.1364), Implementation (0.3173) and Flexibility (0.2765). Thus, as we can see that the criteria of Implementation and Flexibility have the two biggest relative weights among others which are 0.3173 and 0.2765. However, the criteria have been chosen by us, that can be used by SMEs in ERP selection, mostly depends on academic researches, and the weights assigned fully rest on the questionnaires that we have got from 44 SMEs in China. Other researchers could possibly get different results by assigning different weights to the selection criteria and sub-criteria by doing the research in different countries or areas. Although the method used is the same, the results may

change.

By knowing these results from the questionnaire, we interviewed an IS manager who responded to our questionnaire, in order to investigate what was the reasons that made him think the Implementation and Flexibility are the most important criteria when selecting an ERP Provider as shown in the data analysis part. Refer to his company, a small sized company, which has the limited resources and capital, and his company often put money in production, adding new products, public relations and so on (Chen Xin, Telephone Interview, 18 April, 2010). He believes that the investment in these areas could soon produce benefits for the company. That is true, unlike the big sized companies; they cannot afford the vast money and time that invest in the ERP software implementation and service. Once the money has been invested into the ERP software, a quick return from the ERP system is needed. However, if it takes more than one year for implementing the ERP software in a company, and requires complex business process reengineering, it is likely to drag the company down, especially for SMEs. According to the survey mentioned by Liu Tong (2009), it should generally take less than 3 months to complete the whole implementation process of ERP for SMEs.

On the other hand, since some SMEs do not have many or even no professional computer technicians in their organizations, the ERP software for SMEs must have a great ease of use and easy to learn (Chen Xin, Telephone Interview, 18 April, 2010). In other words, instead of increasing their workload, the ERP software should be able to help these SMEs to streamline their work flow and to improve management efficiency. Also as we discussed in the theoretical part, the SMEs are in the growth stage and fast-changing, and in order to suit the organizational culture and business strategy, even though some business strategies are changed or added, the ERP software need to have a great flexibility to adapt the changing demand.

Nevertheless, this is not saying that the other criteria are not as important as the implementation and Flexibility; the Functionality, Maintenance, Financing option and

Vender Credentials are also crucial aspects to consider when selecting an appropriated ERP provider in different backgrounds and business goals of each organization. As Olson (2007) said that the recent trends on the part of vendors to reduce implementation time probably reduces the ERP installation cost. He explained that the cost is the criterion which is clearly an important matter, but there are other factors which are important in order to select the best-fit ERP provider as well. From his survey's results, the ERP functionality and quality are reported to be important criteria as well as the implementation cost. This is just an example which shows the ranking of the criteria in our thesis and it should not be completely applied when a company is selecting an appropriate ERP provider, however, these decision makers are aimed to use our results as a reference, and take their own situation and condition into account. For small- or medium-sized ERP providers, our thesis could be used by them as a marketing analysis report which reveals the criteria that SMEs concern about when they are choosing an ERP provider. Moreover, these ERP providers who want to earn a competitive advantage on the SME's market might improve themselves in the six main criteria we mentioned in our thesis.

---

## 6. Conclusion

---

*To summarize our research we will present the conclusion of our thesis in this chapter. In the conclusion we claimed that we have answered our research questions and achieved our research purpose. Limitations and further research are also presented in this chapter.*

---

### 6.1 General Conclusion

To implement an ERP project successfully and improve their competence in the nearby future, it is necessary to choose an ERP system which can be aligned with the special needs and demands of the organization. The purpose of our thesis is to explain and conceptualize a systematic decision making approach for SMEs by using the AHP method to choose an appropriate ERP provider by addressing the two level evaluation criteria system which was constructed from our study. The first level criteria include Vendor credentials (VC), Financing option (FO), Maintenance (Main), Functionality (Func), Flexibility (Flex), and Implementation (Impl). In the second criteria level, the Vendor credentials consists of Vendor reputation (VR), Market share (MR) as well as the Demonstrations of previous implementation (Demo); the Financing option includes Software cost (SC), Consulting and Maintenance/upgrade cost (CC) and How to pay for the investment (HTP); the Maintenance includes After sale service and training (ASS) and Updating and Inquires (UI); the Implementation consists of Customization (CUST) and Ease of integration (Inte).

From our survey, it indicates that those SMEs of our sample companies take more consideration on Implementation and Flexibility among other criteria when selecting an ERP provider. These results can answer our research questions 1 which was proposed earlier regards to the selecting criteria. In accordance with these results, a systematic method for selecting an ERP system for SMEs is proposed and presented. Thus, the research question 2 has been answered in our research.

At last, the contribution of our thesis is not only to formalize the knowledge related to the Decision support system and ERP selection criteria for SMEs but our thesis can also be useful to both the SMEs decision maker and the ERP provider. In addition, the AHP method is a practical and easy-to-learn approach, and it can ensure the reasonable decisions as well. Furthermore, the systematic method presented in our thesis can be easily extended to the analysis of other similar decision problems under a complicated and fuzzy environment.

## **6.2 Limitation**

Referring to all questionnaires, approximately 73 in total, that were sent to small- and medium- size enterprise in China, and only 44 replied. Therefore, the amount and area of the questionnaire is limited which could probably lead to our limited research results that only can be used in the particular area and industry in China. However, this also results in our interest in further research.

In addition, we decided to focus on only six main criteria with ten more sub-criteria in our research which can be used for creating twenty-seven questions in the spread out questionnaires. It might not be possible to cover all criteria which are important for SMEs in order to select an appropriated ERP provider in the real-world business.

## **6.3 Further Research**

Further research is needed to investigate the differences and effects in the implementation process and the actual usage of the selected ERP system by using the systematic approach we have presented as above after the selection process. However, the AHP method cannot support all ERP selection and implementation processes. Thus, an intelligent decision support system or expert system which consists of other methods besides AHP could be used when gathering data for ERP selection process.



Moreover, as all the results which have been used in AHP calculations in this research are only from China, it is possible to do further studies in the same topic all over the world in order to apply the research result to the real world of business; questionnaires should send out to other countries or at least to other regions, such as Europe or America to see if there are any different in criteria which can be used in order to decide which ERP provider in the market is appropriated for small- and medium- size organizations, as well as possible to serve their businesses' strategies. The results from this study can be compared to other countries to see the possible of regional differences.

In addition, as we have mentioned earlier the AHP technique is used in this research, other methodologies or calculation techniques might be applied to see if the same result would be provided, to confirm the results from questionnaires in selecting an appropriated ERP provider.

## 7. Appendix I

### Questionnaire

#### To be completed by:

- (a) A IS (Information System) manager of small to medium sized company.
- (b) A person who is responsible for management and maintenance the Information system within an enterprise.

We hereby sincerely appreciate your time and helps in filling in this questionnaire, and your response will help us finish our Thesis in a better way, also we might help you to make your decisions when you are eager but hesitate to implement an ERP system in your company, or if you have already has an ERP system in your enterprise, our study might enhance the performance of the system in your organization.

Your answers will be analyzed as part of data to generalize the universal cognition of SMEs about the criteria for choosing an ERP Provider. Your company's contributions will be made anonymous and the final report and analysis will be provided to you upon completion.

You may contact any member of our research team with questions or concerns you may have. The contact information as following:

Sen Yang, [Tel:\(0046\)765828998](tel:0046765828998), Patchara Boonyaprasit, [Tel:\(0046\)765669614](tel:0046765669614),  
email: [Sen.Yang@hermes.ics.lu.se](mailto:Sen.Yang@hermes.ics.lu.se), email: [Patchara.Boonyaprasit@hermes.ics.lu.se](mailto:Patchara.Boonyaprasit@hermes.ics.lu.se)

We appreciate your great help! We look forward to your response.

Sincerely,

Patchara Boonyaprasit and Sen Yang

Department of Informatics

School of Economics and Management

Lund University, SE-220 07, Lund

**Background Information**

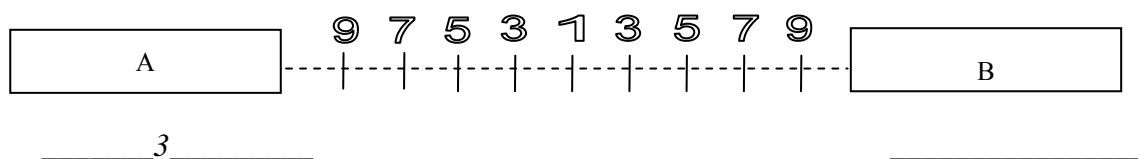
1. What is your position in the company
  - a. IS manager
  - b. IS staff member
  - c. Senior Systems Analyst
  - d. Manager of programming
  - e. Machine or Computer operator
  - f. Other, please specify \_\_\_\_\_
  
2. How long have you been working with this company?
  - a. less than 1 year
  - b. 1-3 years
  - c. 4-6 years
  - d. 7-9 years
  - e. more than 10 years
  
3. Have you ever had any experience in ERP implementation? If yes, please specify the role, such as system analyst or software tester.
  - a. No
  - b. Yes, what was your role? \_\_\_\_\_
  
4. Do you have an ERP system in your organization now? If so, please specify the brand of the ERP system which is currently being used.
  - a. No
  - b. Yes, what is the brand? \_\_\_\_\_
  
5. Please estimate how many employees in your company? \_\_\_\_\_

Please evaluate each of attributes about the criterion for selecting an appropriated ERP provider for your organization. Beside each criterion, put the level of preference either of side on the line provided below the attribute, from Equally preferred to Extremely, an example is given below. The scales of preference between two attributes are showing in the Table 1 (T.L. Satty, 2000)

**Table 1:** Scale of preference between two attributes

Preference weights ( level of importance)	Definition	Explanation
1	Equally preferred	Two criterions equally to the select the ERP provider
3	Moderately	Experience and judgment slightly favor one criterion over another
5	Strongly	Experience and judgment strongly or essentially favor one criterion over another
7	Very Strongly	A criterion is strongly favored over another and its dominance demonstrated in practice.
9	Extremely	The evidence favoring one criterion over another is of the highest degree possible of affirmation.
2,4,6,8	Intermediate values	Used to represent compromise between the preferences listed above
Reciprocals	Reciprocals for inverse composition	

For example,



This means, the “A” attribute is slightly favor over the attribute of “B”. On the other hand, if you put the same number on “B” side, means, “B” attribute is slightly favor over the attribute of “A”.

In this questionnaire, there are six main criterions, based on some previous study and our investigation for selecting an appropriated ERP provider, which are:

Criteria	Sub-criteria
<b>Non-functional requirements</b>	
Vendor credentials	Vendor reputation (VR)
(VC)	Market share (MS)
	Demonstrations of previous implementation (Demo)
Financing option	Software cost (SC)
(FO)	Consulting and Maintenance/upgrade cost (CC)
	How to pay for the investment(time and way) (HTP)
Maintenance	After sale service and training (ASS)
(Main)	Updating and Inquires (UI)
<b>Functional requirements</b>	
Functionality (Func)	
Flexibility (Flex)	
Implementation	Customization (CUST)
(Impl)	Ease of integration(time consuming and effect of integration)
	(Inte)

**Table 2:** the criteria and sub-criteria of selecting an ERP Provider

**Vendor credentials:** there are three sub-criteria in Vendor credentials, which are Vendor's reputation, market share and the demonstration of previous implementation. They are three main factors for judging the vendor credentials, which SMEs can ensure about the ERP providers, since reputation and market share are possible to indicate provider's performance. The demonstration of previous implementation can be used to

check how efficiency of their ERP system. *In a word, the criterion Vendor credentials indicate the fame of the ERP Provider in the market.*

**Financing option:** Software cost, Consulting and Maintenance/upgrade cost, and How to pay for the investment are three sub-criteria in this dimension. To choose an appropriate provider, implementation cost is on the high rank in decision making process for SMEs, including after-sales service in case some unpredicted problem occurs, and employee's training cost to train how to use it. Refer to there are small- and medium-size company; they might not comfortable to pay the big amount of money at once. Hence, it seems to be important for an organization how to pay for the investment and how long they need to pay for it. *Overall, Financing option represent the whole cost of the ERP system and the way to pay for it.*

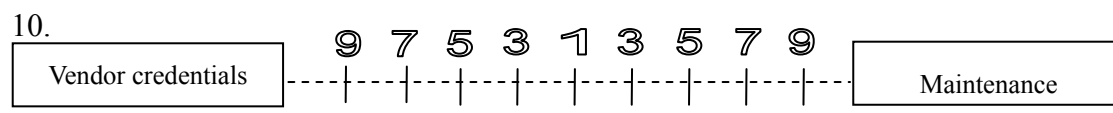
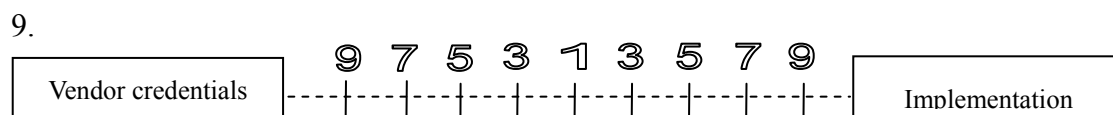
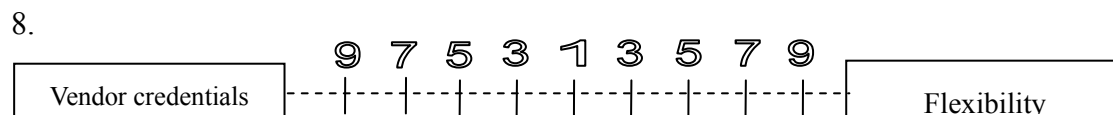
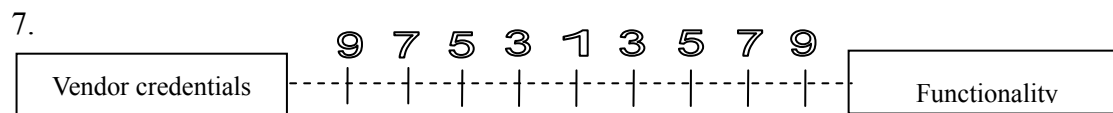
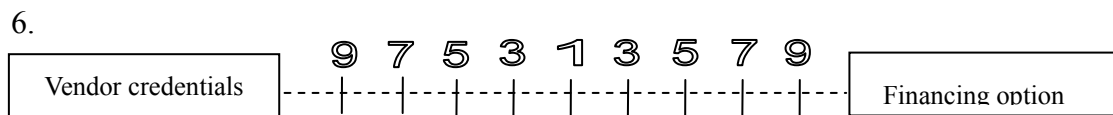
**Maintenance:** the dimension maintenance concerns about the After-sale service and training as well as the Real-time change and online inquires. The training should be provided, and also the after-sales service. Thus, users will clearly understand software's features and its capability. *Clearly, this criteria indicates the services after the ERP system settle down.*

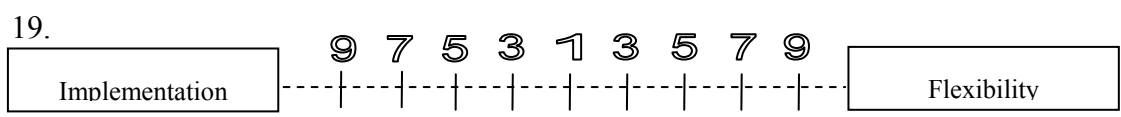
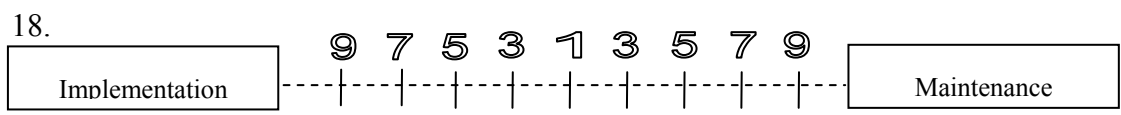
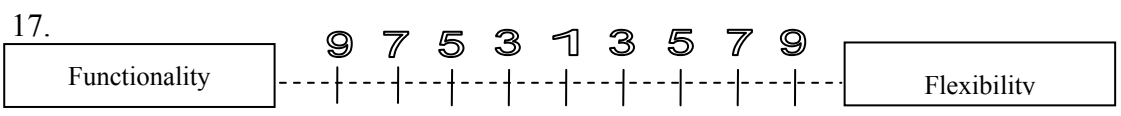
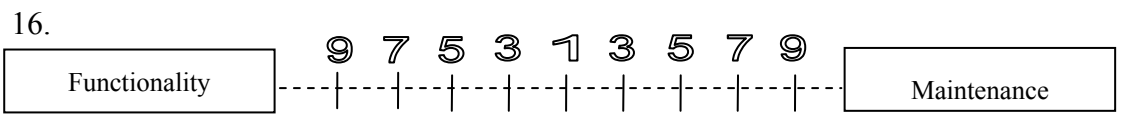
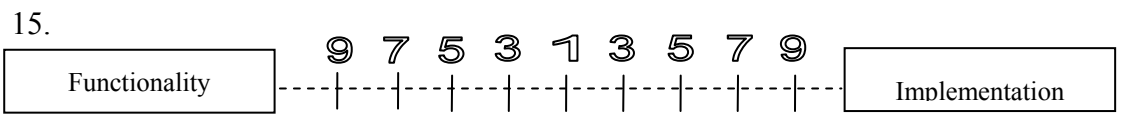
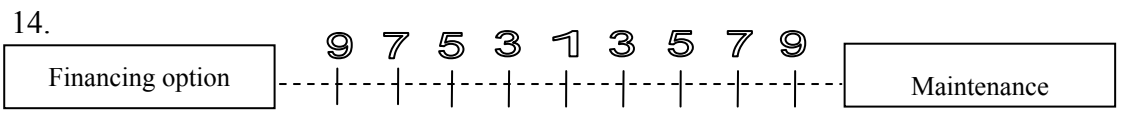
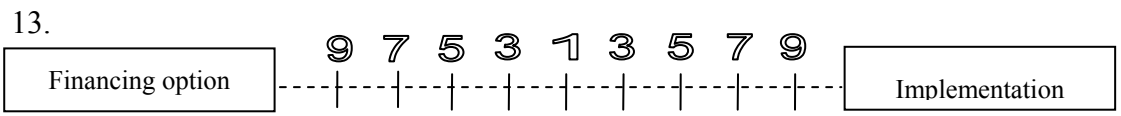
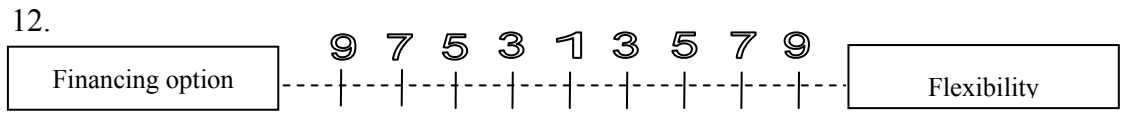
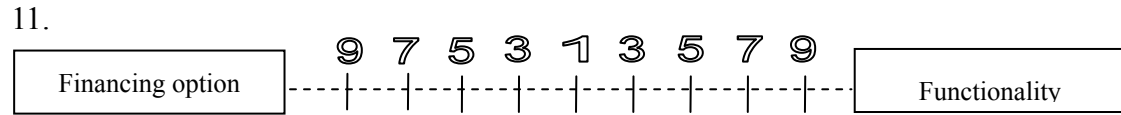
**Functionality,** different companies ask for different system functions due to their unique requirements, which normally include Product Configuration, Distribution Requirements Planning, Quality Assurance/Management, Customer Service Management, Human Resources Management, Sales and Operations Planning, Maintenance Management, Warehouse Management, Transportation Management, Supply Chain Execution Management and etc. *Here, the functionality means how many and how good the functions that the ERP system can provide.*

**Flexibility,** which means the system, should be ease of use; the system should not be too complex in design but well-managed user interface. And have the capability to support the needs of the business over its lifetime, in order to suit the organizational culture and

business strategy, even though some business strategies are changed or added. *So, the flexibility represents the degree of ease of use of the ERP system and how well the system can work along with the business over its lifetime.*

**Implementation:** Customization and Ease of integration are quite critical issue when implement the ERP system in organization. Since different organizations need different software, they need to adapt the available ERP in the market for their own use along with their previous software in their organization. Thus, the ERP modules should be integrated and provide seamless data flow among the other modules, increasing operational transparency. Furthermore, ERP should be available to exchange data with the application. *Implementation describes how the new ERP system can be adapted and integrated with your current system as well as the time consuming during the implementation process, and it can customize the unique system in accordance with your business strategy.*







**Sub-criteria:**

**Vendor Credential**

20.

Vendor reputation	9 7 5 3 1 3 5 7 9		Market share
-------------------	-------------------	--	--------------

---



---

21.

Vendor reputation	9 7 5 3 1 3 5 7 9		Demonstration*
-------------------	-------------------	--	----------------

---



---

*\*Demonstration means the demonstration of all function(s) and system's capability before the previous implementation.*

22.

Market share	9 7 5 3 1 3 5 7 9		Demonstration*
--------------	-------------------	--	----------------

---



---

**Financial option**

23.

Software cost	9 7 5 3 1 3 5 7 9		Consulting cost*
---------------	-------------------	--	------------------

---



---

*\*Consulting cost is also including the Maintenance/upgrade cost*

24.

Software cost	9 7 5 3 1 3 5 7 9		How to pay*
---------------	-------------------	--	-------------

---



---

*\*How to pay for the investment (time and way e.g. divided payment)*

25.

Consulting cost	9 7 5 3 1 3 5 7 9		How to pay*
-----------------	-------------------	--	-------------

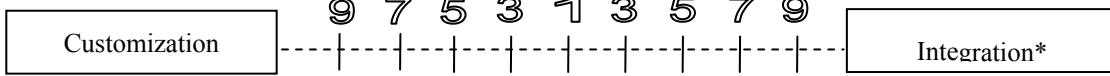
---



---

**Implementation**

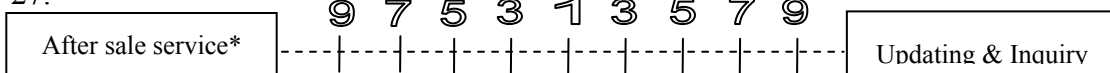
26.



*\*Ease of Integration (time consuming and effect of integration)*

**Maintenance**

27.



*\*After sale service, including training course*

Please specify if you have any other criterion for selecting an appropriate ERP provider, which have not mentioned on this questionnaire.

---



---



---

## 8. Appendix II

### Interview Guide

By following the standard procedures claimed by Kvale and Brinkmann (2008) and Creswell (2007), we started the interview by designing the interview guide as following:

*1. Target the interviewees' group;* Creswell (2007) explain that in order to get the right information, the study should focus on participants who have enough experience on that field/area. The study participants on this research will be the information system managers or employees in small- and medium- size organizations who participated in the ERP system implementation in China.

*2. Determine what type of interview will be used as the most appropriate one and will get the most useful information and data.* The telephone interview would be used due to the distance between interviewer and interviewee.

*3. Using the appropriate recording procedures.* Under the agreement with the premise in recording the conversation with the interviewee, we will use recorder to record the dialog and transcript them into a written document.

*4. Design and use an interview protocol.* We designed an interview protocol about how the question developed and the motivation, in order to help the interviewee to have a deep understanding of the question he/she is going to answer. In our research, the interview questions are based on the questionnaire questions.

*5. Refine the interview questions.* If there are some limitations in our interview questions we will refine and complement it, once we find it before, after or during the interviewing.

*6. Others.* Such like after arriving at the interview place, we have to obtain consent from the interviewee to participate in the study, during the interview, stay to the question and complete the interview within the specified time as well as the ethic issues we need to pay attention to.

## 9. Appendix III

### A transcription of the telephone Interview with Mr. Chen Xin/ IS manager\*

A: standards for authors' questions; C: standards for Chen Xin's answers

A: Have you had experience of implementing an ERP system in an organization? How was that?

C: Yes, I have. It was three years ago, and it was the first time for me to take part in an ERP system implementation project. At first it was hard, many things you have to think about and to know how the new system can work along with our current system. We had limited resources and capital for this project, and their management did not take very seriously about this project compare to the production, new products, and public relations. Anyhow, it was a good experience for me, and I learnt a lot from that project.

A: Why implement an ERP system? What are the benefits of an ERP System?

C: That's because as the demands of our company on information sharing is increasing, and the old system cannot satisfy our needs from different departments. However, ERP system integrates all departments and functions across an organization onto single software that can provide the particular needs of all those different departments. Thus, the various departments can share information and communicate easier with each other, and get the specific and particular functions from this system to make their work more efficiency.

A: Why do you think the implementation and flexibility are the top two criteria that SMEs need to focus on when selecting an ERP provider?

C: Hmm..., unlike the big sized companies we do not have enough money and time that can be invested in the ERP system implementation. Once the money has been invested into the ERP software, we want a quick return from the ERP. If the implementation takes a long time, we will be overwhelmed by it. So, the implementation time must be short. Talking about the flexibility, since we do not have many or even no professional computer technicians in our company, the ERP software must be easy to learn and use.

*\*The interview language was in Chinese*

## 10. Appendix IV

### Calculation Process

To select the best appropriate provider according to the criterions have mentioned earlier, the overall priority for each alternative solution would be calculated by the formula:

*The weight of the attribute regards to the goal\* the weight of the attribute regards to alternatives = priority*

Criteria	Sub-criteria	PV (Priority Vector)	PV for ERP provider A	PV for ERP provider B
Vendor credentials (VC)		0.0504		
	Vendor reputation (VR)	0.0897	0.25	0.75
	Market share (MS)	0.607	0.25	0.75
	Demonstrations of previous implementation (Demo)	0.3033	0.5	0.5

Hence,

The ERP provider A's overall priority under sub-criteria *Vendor reputation (VR)* is:

$$0.0504 * 0.0897 * 0.25 = 0.00113$$

The ERP provider B's overall priority under sub-criteria *Vendor reputation (VR)* is:

$$0.0504 * 0.0897 * 0.75 = 0.003391$$

The ERP provider A's overall priority under sub-criteria *Market share (MS)* is:

$$0.0504 * 0.607 * 0.25 = 0.007648$$

The ERP provider B's overall priority under sub-criteria *Market share (MS)* is:

$$0.0504 * 0.607 * 0.75 = 0.022945$$

The ERP provider A's overall priority under sub-criteria *Demonstrations of previous implementation (Demo)* is:

$$0.0504 * 0.3033 * 0.5 = 0.007643$$

The ERP provider B's overall priority under sub-criteria *Demonstrations of previous implementation (Demo)* is:

$$0.0504 * 0.3033 * 0.5 = 0.007643$$

Criteria	Sub-criteria(s)	PV (Priority Vector)	PV for ERP provider A	PV for ERP provider B
Financing option (FO)		0.1316		
	Software cost (SC)	0.4545	0.125	0.875
	Consulting and Maintenance/upgrade cost (CC)	0.4545	0.2	0.8
	How to pay for the investment(time and way) (HTP)	0.0909	0.25	0.75

The ERP provider A's overall priority under sub-criteria *Software cost (SC)* is:

$$0.1316 * 0.4545 * 0.125 = 0.007477$$

The ERP provider B's overall priority under sub-criteria *Software cost (SC)* is:

$$0.1316 * 0.4545 * 0.875 = 0.052336$$

The ERP provider A's overall priority under sub-criteria *Consulting and Maintenance/upgrade cost (CC)* is:

$$0.1316 * 0.4545 * 0.2 = 0.011962$$

The ERP provider B's overall priority under sub-criteria *Consulting and Maintenance/upgrade cost (CC)* is:

$$0.1316 * 0.4545 * 0.8 = 0.04785$$

The ERP provider A's overall priority under sub-criteria *How to pay for the investment (time and way) (HTP)* is:

$$0.1316 * 0.0909 * 0.25 = 0.002991$$

The ERP provider B's overall priority under sub-criteria *How to pay for the investment (time and way) (HTP)* is:

$$0.1316 * 0.0909 * 0.75 = 0.008972$$

<b>Criteria</b>	<b>PV (Priority Vector)</b>	<b>PV for ERP provider A</b>	<b>PV for ERP provider B</b>
Functionality (Func)	0.1364	0.8333	0.167

The ERP provider A's overall priority under criteria *Functionality (Func)* is:

$$0.1364 * 0.8333 = 0.113662$$

The ERP provider B's overall priority under criteria *Functionality (Func)* is:

$$0.1364 * 0.167 = 0.022779$$

<b>Criteria</b>	<b>PV (Priority Vector)</b>	<b>PV for ERP provider A</b>	<b>PV for ERP provider B</b>
Flexibility (Flex)	0.2765	0.8571	0.1429

The ERP provider A's overall priority under criteria *Flexibility (Flex)* is:

$$0.2765 * 0.8571 = 0.236988$$

The ERP provider B's overall priority under criteria *Flexibility (Flex)* is:

$$0.2765 * 0.1429 = 0.039512$$

Criteria	Sub-criteria(s)	PV (Priority Vector)	PV for ERP provider A	PV for ERP provider B
Implementation (Impl)		0.3173		
	Customization (CUST)	0.25	0.8333	0.1667
	Ease of integration(time consuming and effect of integration) (Inte)	0.75	0.8571	0.1429

The ERP provider A's overall priority under sub-criteria *Customization (CUST)* is:

$$0.3173 * 0.25 * 0.8333 = 0.066102$$

The ERP provider B's overall priority under sub-criteria *Customization (CUST)* is:

$$0.3173 * 0.25 * 0.1667 = 0.013223$$

The ERP provider A's overall priority under sub-criteria *Ease of integration (time consuming and effect of integration) (Inte)* is:

$$0.3173 * 0.75 * 0.8571 = 0.203968$$

The ERP provider B's overall priority under sub-criteria *Ease of integration (time consuming and effect of integration) (Inte)* is:

$$0.3173 * 0.75 * 0.1429 = 0.034007$$

Criteria	Sub-criteria(s)	PV (Priority Vector)	PV for ERP provider A	PV for ERP provider B
Maintenance (Main)		0.0878		
	After sale service and training (ASS)	0.75	0.1667	0.8333
	Updating and Inquires (UI)	0.25	0.8	0.2



The ERP provider A's overall priority under sub-criteria *After sale service and training (ASS)* is:

$$0.0878 * 0.75 * 0.1667 = 0.010977$$

The ERP provider B's overall priority under sub-criteria *After sale service and training (ASS)* is:

$$0.0878 * 0.75 * 0.8333 = 0.054873$$

The ERP provider A's overall priority under sub-criteria *Updating and Inquires (UI)* is:

$$0.0878 * 0.25 * 0.8 = 0.01756$$

The ERP provider B's overall priority under sub-criteria *Updating and Inquires (UI)* is:

$$0.0878 * 0.25 * 0.2 = 0.00439$$

Thus, the summation of the ERP provider A is

$$0.00113 + 0.007648 + 0.007643 + 0.007477 + 0.011962 + 0.002991 + 0.113662 + 0.236988 + 0.066102 + 0.203968 + 0.010977 + 0.01756 = \mathbf{0.6881}$$

And the ERP provider B is

$$0.003391 + 0.022945 + 0.007643 + 0.052336 + 0.04785 + 0.008972 + 0.022779 + 0.039512 + 0.013223 + 0.034007 + 0.054873 + 0.00439 = \mathbf{0.3119}$$

## 11. References

- Alanbay, O., 2005. *ERP SELECTION USING EXPERT CHOICE SOFTWARE*. Honolulu, Hawaii, July 8-10.
- Anderegg, T., 2010. MRP/MRP II/ERP/ERM — Confusing Terms and Definitions for a Murky Alphabet Soup, [Online] (Updated 1 October 2007). Available at: <http://www.wlug.org.nz/EnterpriseSpeak>. [Accessed: 2010/3/23]
- Avraham S., 2002. *Enterprise. Resource Planning (ERP): The Dynamics of Operations Management*, Kluwer Academic Publishers.
- Babey, E.R., 2006. Costs of enterprise resource planning system implementation— And then some. *New Directions for Higher Education*, 136, pp. 21–33.
- Bernroider, E. & Koch, S., 2001. ERP selection process in midsize and large organizations, *Business Process Management Journal*, Vol.7, Issue 3, pp. 251-257
- Bhushan, N. & Kanwal, R., 2004. *Strategic decision making: applying the analytic hierarchy process*, London: Springer-Verlag.
- Birdogan, B. Kemal, C., 2005. Determining the ERP package-selecting criteria: The case of Turkish manufacturing companies. *Business Process Management Journal*. Year: 2005 Volume: 11 Issue: 1 pp. 75-86
- Bosch, J. & Molin, P., 1999. Software architecture design: Evaluation and transformation. *In Proceedings of the IEEE engineering of computer based systems symposium (ECBS99)*, pp. 4–10.
- Cebi, S. & Kahraman C., 2010. Developing a group decision support system based on fuzzy information axiom. *Knowledge-Based Systems* Vol. 23, Issue 1, pp. 3–16.
- Celeste, S.P.N. Gable, G. & Chan, T., 2003. An ERP Maintenance Model. *hicss*, vol. 8, pp.234b, 36th Annual Hawaii International Conference on System Sciences (HICSS'03) - Track 8, 2003
- Chaudhary, R., 2007. Vendor Credentials Influence Customer Decisions. [Online] (Updated 21 September 2007). Available at: <http://biztech2.in.com/india/interviews/erp/vendor-credentials-influence-customer-decisions/6811/0>. [Accessed: 14 April 2010]
- Chen, I.J., 2001. Planning for ERP systems: Analysis and future trends. *Business Process Management Journal*, 7(5), pp. 374–386.
- Chen, S.-G., & Lin, Y.-K., 2009b. On performance evaluation of ERP systems with fuzzy mathematics. *Expert Systems with Applications*, 36(2P2), pp. 6362–6367.
- Cliff, S., 2006. *Businesses 'only using 50% of ERP functionality*, *Computer Weekly*; 3/14/2006, pp. 4-4.

- Coyle, G., 2004. The Analytic Hierarchy Process (AHP). Coyle, G., *Practical Strategy: Structured Tools and Techniques*, Glasgow: Pearson Education Ltd.
- Cragg, P.B. & Zinatelli, N., 1995. The evolution of information systems in small firms. *Information and Management*, 29(3). pp 1–8.
- Creswell, J.W., 2007. *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*, 2nd ed. London: Sage Publications Ltd.
- Crowe, T.J. Noble, J.S. & Machimada, J.S., 1998. Multi-attribute analysis of ISO 9000 registration using AHP, *International Journal of Quality Reliability Management*, Vol. 15 No. 2, pp. 205-22.
- Davenport, T. H., 1996. *Holistic Management of Mega-Package Change: The Case of SAP*. Boston, Center of Business Innovation, Ernst and Young LLP.
- Davenport, T.H., 1998. "Putting the Enterprise into the Enterprise System." *Harvard Business Review* 76(4): pp. 121-131.
- Ehie, I.C. & Madsen, M., 2005. Identifying critical issues in enterprise resource planning (ERP) implementation, *Computers in Industry* 56 (6) pp. 545–557
- Gross, J., 2010. ERP Maintenance: Consider During ERP Planning Phase. [Online] (Updated 2 April 2010). Available at: <http://it.toolbox.com/blogs/junction/erp-maintenance-consider-during-erp-planning-phase-36772>, [Accessed: 29 April 2010]
- Hecht, B., 1997. Managing resources – choose the right ERP software. *Datamation*, Vol. 43 No.3, pp.56-8.
- He, I. & Li, C., 2009. A Method for Selecting ERP System Based on Fuzzy Set Theory and Analytical Hierarchy Process. *Global Congress on Intelligent Systems*. vol. 1, 2009 IEEE.
- Hildreth, S., 2004. Big-time ERP in a small-business box. [Online] (Updated 22 July 2004). Available at: [http://searchcio-midmarket.techtarget.com/news/article/0,289142,sid183\\_gci995065,00.html](http://searchcio-midmarket.techtarget.com/news/article/0,289142,sid183_gci995065,00.html). [Accessed: 22 March 2010]
- Foley, O.M., 2007. ERP for Small Business: The Time is Ripe. [Online]. Available at: <http://technology.inc.com/software/articles/200710/ERP.html> [Accessed: 22 March 2010]
- Israel, M.A. & Hay, I.M., 2006. *Research ethics for social scientists: between ethical conduct and regulatory compliance*. London: Sage Publications
- Jenson, R.L. & Johnson, I.R., 1999. The enterprise resource planning system as a strategic solution. *Information Strategy: The Executive's Journal*. Vol. 15 No. 4, pp. 28-33.
- Jessup, L.M. & Tansik, D.A., 1991. Decision making in an automated environment: The

- effect of anonymity and proximity with a Group Decision Support System. *Decision Sciences*, 22(2), pp. 266-279
- Kannan, G., 2008. Fuzzy approach for the selection of third party reverse logistics provider, *Asia Pacific Journal of Marketing and Logistics*, Vol. 21 No. 3, 200 pp. 397-416
- Karaarslan, N. & Gundogar, E., 2009. An application for modular capability-based ERP software selection using AHP method. *The international journal of advanced manufacturing technology*. Year: 2009 Volume: 42 Issue: 9, pp. 1025-1033
- Karlsson, J. 1997. Managing software requirements using quality function deployment, *Software Quality Control*, v.6 n.4, pp. 311-326.
- Karsak, E.E. & Özogul, C.O., 2009. An integrated decision making approach for ERP system selection. *Expert Systems with Applications*, 2009, 36, pp.660–667.
- Kimberling, E., 2006. Do Small Businesses Need ERP?, *In Search of Business Value and ROI: Achieving IT Benefits Realization*. [Online] (Updated 29 June 2006). Available at: <http://it.toolbox.com/blogs/erp-roi/do-small-businesses-need-erp-10215>. [Accessed: 22 March 2010]
- Kimberling, E., 2010. Three Reasons Not to Cancel Your ERP Maintenance. [Online] (Updated 8 March 2010). Available at: <http://it.toolbox.com/blogs/erp-roi/three-reasons-not-to-cancel-your-erp-maintenance-36999>. [Accessed: 29 April 2010]
- Klaus, H. Rosemann, M. & Gable, G.G., 2000. What is ERP?. *Information Systems Frontiers* 2:2 pp. 141-162.
- Kvale, S., 1996. *InterViews: An Introduction to Qualitative Research Interviewing*. London: Sage Publications Ltd.
- Kvale, S. & Brinkmann, S., 2008. *Interviews: Learning the Craft of Qualitative Research Interviewing*, 2nd ed. London: Sage Publications Ltd.
- Lapin, Y., 2009. Guidelines on Research Ethics. Good Scientific Practice. Univeristy of Lapland.
- Laudon, K.C. & Laudon, J.P., 1998. *Management Information Systems – New Approaches to Organization & Technology*, 5th ed, Prentice-Hall, London.
- Liang, S.K. & Lien, C.T., 2007. Selecting the Optimal ERP Software by Combining the ISO 9126 Standard and Fuzzy AHP Approach. *Contemporary Management Research*. vol.3, no.1, pp.23-44.
- Liu, T., 2009. Talking about the ERP of SMEs (谈论中小型企业ERP), [Online] (Updated 4 December 2009). Available at: <http://www.access-cn.com/offspace/html/70/n-170.html>. [Accessed: 22 April 2010]
- Loh, T.C. & Koh, S.C.L., 2004. Critical elements for a successful enterprise resource

- planning implementation in small and medium sized enterprises. *International Journal of Production Research*, 42(17), pp. 3433–3455
- Malhotra, R. & Temponi, C. (2010), Critical decisions for ERP integration: Small business issues, Elsevier, *International Journal of Information Management*, Vol. 30, Issue 1, pp. 28-37
- Markus, M.L. & Yanis, C., 2000. P.C. can Fenema, multisite ERP implementations. *Communications of the ACM*, 43, pp. 42–46. April.
- Marakas, M.G., 2002. *Decision Support Systems in the 21st Century(second edition)*. Upper Saddle River, New Jersey.
- McCall, J. Richards, P. & Walters, G., 1977. Factors in Software Quality. Three volumes, NTIS AD-A049-014, AD-A049-015, AD-A049-055, November 1977.
- Monk, E. & Wagner, B., 2006. *Concepts in Enterprise Resource Planning* (Second ed.), Boston: Thomson Course Technology
- Morrison, J.G. Kelly, R.T. Moore, R.S. & Hutchins, S.G., 2000. Implications of Decision Making Research for Decision Support and Displays. J. A. Cannon-Bowers and E. Salas (Eds.), *Decision Making Under Stress: Implications for Training and Simulation*.
- Muscatello, R.J. Small, H.M. & Chen, J.I., 2003. "Implementing enterprise resource planning (ERP) systems in small and midsize manufacturing firms". Emerald Group Publishing Limited, *Ebsco*, Vol. 23, Issue. 8, pp. 850-872.
- Nah, F.F-H., & Lau, J.L.S., 2001. Critical factors for successful implementation of enterprise systems. *Business Process Management Journal*, 7(3), pp. 285–296.
- Norris, N., 1997. Error, bias and validity in qualitative research. *Educational Action Research*, 5(1), pp. 172-176.
- Olson, L.D., 2007. Evaluation of ERP outsourcing, Department of Management, University of Nebraska-Lincoln, *Computers and Operations Research* 34 (2007) pp. 3715 – 3724.
- Power, J.D., 2008. *Decision Support Systems: A Historical Overview*. International Handbooks Information System. Springer Berlin Heidelberg. Chapter 7 pp. 121-140.
- Saaty, T.L., 1986. Concepts, theory, and techniques: Rank generation, preservation, and reversal in the Analytic Hierarchy Decision Process. *Decision Sciences*, 18(2), pp. 155-177
- Saaty, T.L., 1990. An Exposition on the AHP in Reply to the Paper “Remarks on the Analytic Hierarchy Process”, *Managemengt science* Vol. 36, No. 3, March 1990.
- Saaty, T.L., 2000. *Fundamentals of Decision Making and Priority Theory, 2nd ed.* RWS, Pittsburgh, PA.

- Seale, C., 1999. *The Quality of Qualitative Research*. London: Sage Publications Ltd.
- Sen, C.G. Baracli, H. Sen, S. & Basligil, H., 2009. An integrated decision support system dealing with qualitative and quantitative objectives for enterprise software selection, *Expert Systems with Applications*, Volume: 36 Issue: 3, pp. 5272-5283
- Shaul, C., 2006. *7 Ways to Fail in an ERP Selection*. [Online] Available at: <http://www.erpandmore.com/2006/06/28/7-ways-to-fail-in-an-erp-selection/>. [Accessed: 22 March 2010]
- Siswanto, J. & Utomo, P.A., 2008. ERP System Selection Model for Low Cost NGN Phone Company. *International Journal of Electronic Business Management*. Volume: 6 Issue: 3, pp. 153-160
- Smith, A., 2009. Selecting a Small Business ERP Solution: Small Business Software Should Not Be “Small”? *In Functionality*. September 3rd, 2009
- Smith, D., 1999. Better data collection for greater efficiency. *Manufacturing Engineering*, Vol. 123 No. 4, pp. 62-8.
- Sprague, R.H. Jr. & Carlson E.D., 1982. *Building Effective Decision Support Systems*. Englewood Cliffs, N.J.: Prentice-Hall.
- Su, F.Y. & Yang, C., 2009. A structural equation model for analyzing the impact of ERP on SCM. *Expert Systems with Applications* 37. Pergamon Vol. 37. Issue 1, pp. 456–469.
- Tavana, M. Kennedy, D. Rappaport, J. & Ugras, Y.J., 1993. An AHP-Delphi Group Decision Support System Applied to Conflict Resolution in Hiring Decisions. *Journal of Management Systems*, Vol.5, 1, pp. 49-74
- Toscani, D. Archetti, F. Quarenghi, L. Bargna, F. & Messina E., 2010. A DSS for Assessing the Impact of Environmental Quality on Emergency Hospital Admissions, *2010 IEEE Workshop on Health Care Management (WHCM)* pp. 1-6.
- Trunick, P.A., 1999. *ERP: Promise or pipe dream?*. Penton Publishing. vol. 40, Issue 1. pp. 23-26
- Tsai, W.H. Lee, P.L. Shen, Y.S. & Yang, C.C., 2009. The relationship between ERP software selection criteria and ERP success, *2009 IEEE International Conference on Industrial Engineering and Engineering Management*, pp. 2222-2226
- Turban, E. Aronson, E.J., 1998. *Decision Support Systems and Intelligent System*, Musee National d’Art Moderne, Paris, France.
- Turban, E. Aronson, E.J. Liang T.P. & Sharda S., 2007. *Decision Support and Business Intelligent System 8<sup>th</sup> edition*, New Jersey.
- Turbide, D., 1999. What is ERP?, *Foundry Management and Technology*, Vol. 127 Issue: 8 pp. 94-98

- Ufuk, C., 2009. Fuzzy AHP-based decision support system for selecting ERP systems in textile industry by using balanced scorecard. *Expert Systems with Applications*. Volume: 36. Issue: 5, pp. 8900-8910
- Umble, E. Haft, R. & Umble, M., 2003. Enterprise Resource Planning: Implementation Procedures and Critical Success Factors. *European Journal of Operational Research*, Vol. 146, No. 2, pp. 241 - 257.
- Wei, C.C. Chien, F.C. & Wang J.J.M., 2004. An AHP-based approach to ERP system selection. *International Journal of Production Economics*. Volume 96, Issue 1, 18 April 2005, pp. 47-62
- Yin, R. K., 2009. *Case Study Research: Design and Methods*, 4th ed., Thousand Oaks, CA: Sage Publications Ltd.
- Zahedi, F., 1986. The analytic hierarchy process – a survey of the method and its applications, *Interfaces*, Vol. 16 No. 4, pp. 96-108.