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A Prototype Decision Support System for ERP Evaluation in Small and Medium Enterprises

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ABSTRACT

This paper presents the work in progress regarding a research project scheduled to be concluded during the latter part of 2006. The purpose of the research is to develop a Decision Support System - which use a model based on the Analytic Hierarchy Process- what will assist managers from Small and Medium Enterprises of Venezuela, in the evaluation process of a ERP system to their organizations.

1) INTRODUCTION

Confronted with intensifying competition, growing markets and increasingly selective customers, Small and Medium Enterprises (SMEs) are constantly in search of ways to achieve better business performance and secure competitive advantage trough effective employment and management of their resources.

To improve business performance, organizations need an efficient planning and control systems that synchronizes planning of all processes across the enterprise. An enterprise resource planning (ERP) system is an integrated enterprise computing system to automate the flow of material, information and financial resources among all functions within an enterprise on a common database.

Because the virtual saturation of the ERP market, vendors have recently moved their attention towards SMEs, by offering simplified and cheaper solutions (Tagliavini et al, 2002) such as compact packages and ERP outsourcing or the application service provision (ASP) (Shakir and Hossain, 2002)

In spite of the benefits potentially offered by ERP systems (Wei and Wang, 2004) experiences on the field show that SMEs often fail in recognizing the economic and organizational impacts related to its use (Tagliavini et al, 2002); as a consequence, the adequate evaluation and selection of an ERP system become a critical decision that should be supported by a structured approach. Moreover Bernroider and Koch (2002) state that "considering ERP software selection with its complex and far-reaching implications poor decision making by SMEs can result in disastrous situations"

This paper proposes a prototype Decision Support System (DSS) to ERP evaluation in SMEs. The DSS uses a model based on the Analytic Hierarchy Process (AHP) method to multicriteria decision making. The aim of the research is to assist to SMEs managers from Venezuela in the ERP evaluation process.

2) LITERATURE REVIEW

A number of methods have been proposed to help organizations make decision in ERP system or other information system (IS) selection, Winter and Leist (1998) developed a cost-based model model of information systems optimization. Sistach and Pastor (2000) propose a method named SHERPA for the evaluation of an ERP system in SMEs. Lee and King (2000) combined the Analytic Network Process and 0–1 goal-programming model to select an IS project. Stefanou (2001) provides a general framework for the ex-ante evaluation of ERP software. Shakir and Hossain (2002) maps six models of decision making for the selection and implementattion of ERP systems. Wei and Wang (2004) propose a model for selecting an ERP system using two-dimensional analysis and fuzzy set theory.

However, the applicability of these methods is often weakened by sophisticated mathematic models or limited attributes to carry out in a real-world ERP system selection decision, especially when some attributes are not readily quantiable, as well as not too easy for SMEs managers to understand.

On the other hand most of above-mentioned methods were developed to be used for large companies rather than SMEs in developing countries.

The Analytic Hierarchy Process (AHP) is a highly flexible decision methodology that can be applied in a wide variety of situations. It is typically used in decision situations which involve selecting one decision alternatives from several candidate decision alternatives on the basis of multiple decision.

The AHP utilization in the ERP evaluation task has been discussed in various studies. For example, Teltumbde (2000) proposed a framework based on the Nominal Group Technique and AHP to select an ERP system. Alarcon (2004) proposes a model based on AHP to ERP selection in manufacturing large companies in Venezuela and, lastly Wei and Wang (2004) have developed a ERP system selection framework using the AHP method. This framework seeks to align the ERP evaluation process with the competitive strategies and goals of companies. However, as stated previously, these methods are suitable just for large companies and not adapted for ERP evaluation in SMEs.

This study presents a prototype DSS for ERP evaluation in SMEs, based on the AHP framework to synthesize decision makers' tangible and intangible measures, inherent in ERP system selection task and facilitates the group decision-making process. The criteria used by the AHP model is based on previous research of Colmenares (2002) which specifies the criteria should be used to software evaluation in SMEs. Furthermore the AHP method have been modified from the usual AHP approach in that a rating scale will be assigned to each subcriteria related to every alternative, instead of assessing direct pairwise comparisions among the alternatives, following the Liberatore's (1987) proposal.

3) THE AHP MODEL FOR ERP EVALUATION

The AHP method, introduced by Saaty (1995), directs how to determine the priority of a set of alternatives and the relative importance of attributes in a multiple criteria decision-making problem. The AHP modeling process involves four phases, namely, structuring the decision problem, measurement and data collection, determination of normalized weights and synthesis-finding solution to the problem. We structured an AHP base hierarchy for ERP evaluation that could be applied by any SME facing the ERP system selection problem.

3.1) Structuring the Decision Problem

This phase involves formulating an appropriate hierarchy of the AHP model consisting of the goal, criteria and subcriteria, and the alternatives. The goal of SMEs is to select the most suitable ERP system. This

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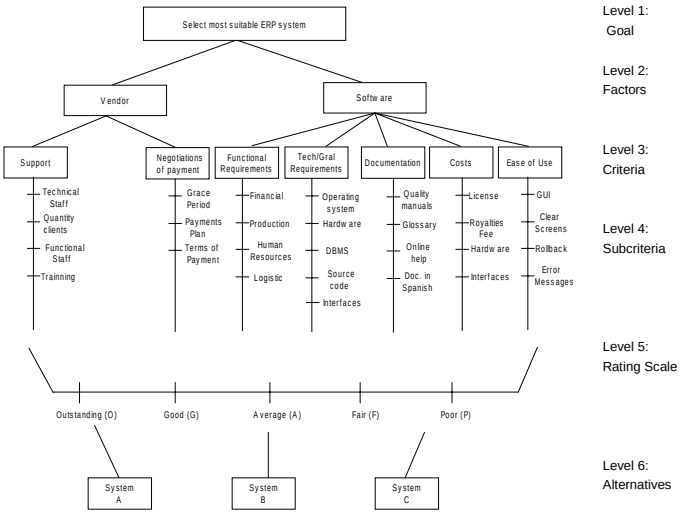
Figure 1. AHP hierarchy



goal is placed on the first level of the hierarchy as shown in figure 1. This is divided into main factors, namely software and vendor (Colmenares, 2002), which form the second level of the hierarchy. The third level of the hierarchy occupies the criteria defining the factors of software and vendor of the second level.

There are two criteria related to vendor, namely support and negotiations of payment. On the other hand, the criteria associated with software are functionals requirements, technical and generals requirements, documentation, costs, and ease of use (Colmenares, 2002)

The fourth level consists of the subcriteria, and is grouped with respect to the seven criteria occupying the third level as shown in Fig. 1 (Colmenares, 2002) The factors, criteria and subcriteria used in these three levels of the AHP hierarchy can be assessed using the basic AHP approach of pairwise comparisons of elements in each level with respect to every parent element located one level above. A set of global priority weights can then be determined for each of the subcriteria by multiplying local weights of the subcriteria with weights of all the parent nodes above it. The fourth level of the hierarchy contains the rating scale. This level is different from the usual AHP approach in that a rating scale will be assigned to each subcriteria related to every alternative, instead of assessing pairwise comparisons among the alternatives in the usual fashion. The use of a rating scale instead of direct pairwise comparisons among alternatives can be found in Liberatore's (1987) study. The main reason for adopting this method is that the evaluation of an ERP system can involve a large number of technical details consisting of several subcriteria. It may be practically too difficult to make pairwise comparisons among the ERP systems with respect to every subcriteria. The use of a rating scale can eliminate these difficulties allowing evaluator assigns a rating to a ERP system without making direct comparisons. As suggested by Liberatore (1987), a five-point rating scale of outstanding (O), good (G), average (A), fair (F) and poor (P) is adopted.

The lowest level of the hierarchy consists of the alternatives, namely the different systems to be evaluated in order to select the most suitable ERP system.

4) THE PROTOTYPE DSS FOR ERP EVALUATION

Decision Support Systems are a type of management information system that enable the decision-making process to be supported from beginning to end (Rojas et al, 2001).The DSS allows modify the AHP hierarchy for the ERP system evaluation problem, by adding or eliminating subcriteria from its fourth level, so constructs the objective hierarchy and the appropriate subcriteria are specified to provide

Figure 2. DSS architecture

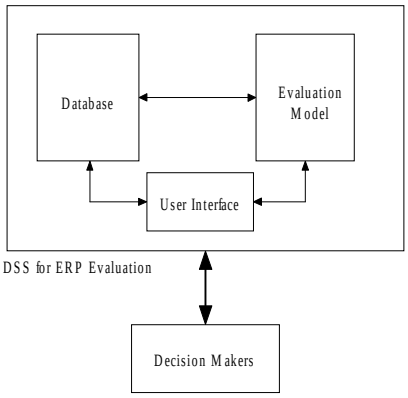
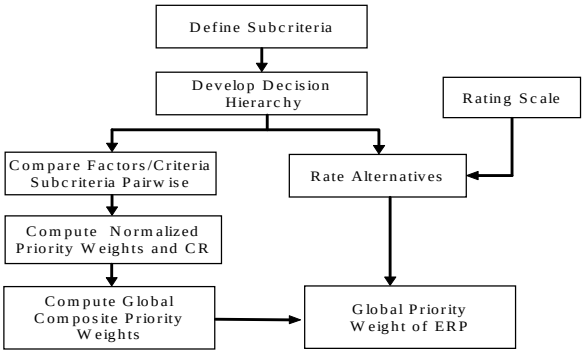


Figure 3. Evaluation model



detailed guidance for the remaining three phases of AHP method. The prototype DSS consists of three parts: evaluation model, user interface and database. The figure 2 shows the DSS architecture.

Next the architecture's components are described.

4.1) Evaluation Model

The model for ERP systems evaluation through AHP method is depicted in figure 3.

The basis for the evaluation model is the AHP hierarchy. This hierarchy is totally defined by selecting the subcriteria from fourth level as stated previously. Then the factors, criteria and subcriteria of the hierarchy must be assessed using the basic AHP approach of pairwise comparisons, using the Saaty's (1995) intensities of importance, in order to establish which criteria are more important than others. The values are then placed in a matrix and the normalized principal eigenvector is found to provide the weighting factors which provide a measure of relative importance for the decision maker. To examine for consistency the principal eigenvalue λ_{max} is calculated. Deviations from consistency are represented by the consistency index (CI), where:

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

Allied to the CI is the consistency ratio (CR), this is the ratio of the CI to the average CI or random index (RI) of a randomly generated reciprocal matrix, i.e. a correction for random error.

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After computing the normalized priority weights for these three levels of the hierarchy, the next phase is to synthesize the solution for the ERP evaluation problem. The normalized local priority weights of factors, criteria and subcriteria obtained previosly are combined together with respect to all successive hierarchical levels to obtain the global composite priority weights of all subcriteria used in the fourth level of the AHP model. The next step is to rate each alternative (ERP system) with respect to each subcriterion, as explained in section 3.1, should be used Liberatore's (1987) five-point rating scale of outstanding (O), good (G), average (A), fair (F) and poor (P). The global priority weight of each ERP system is obtained by multiplying the global priority weight of each subcriterion with the global priority weight of ERP system rating, and adding the resulting values. Finally, these global priority weights need to be normalized.

4.2) User Interface

The prototype DSS for ERP evaluation is being written in REALbasic object-oriented programming language under a compatible PC and it runs on Windows operating system. This tool allows to build a graphical user interface (GUI) through use of menus, radio-buttons, push-buttons, listboxs, and so on. Basics functions of the system consist of:

a) Insert/Modify/Delete data about ERP systems and its vendors.
b) Insert/Modify/Delete data on fourth level of AHP hierarchy.
c) Perform compute of the the weighting factors.
d) Perform compute of the normalized global priority weights.

4.3) Database

The database provides parameters for the model and store the results of the model execution. The database design in two-fold: a logical design and a physical design. The entity-relation model for the logical database design and a relational database scheme using SQLite database manager is being used. Below database's main tables are outlined:

1) ERP (code_ERP, name, code_vendor)
2) Vendor(code_vendor, name, description, …..)
2) Factors(code_factor, description, weight, lambda)
3) Criteria(code_criterion, description, weight, lambda)
4) Subcriteria(code_sub_criterion, description, weight)
5) Rating(code_rating, description, weight)
6) ERPrated(code_erp,code_sub_criterion,code_rating)

5) SUMMARY AND CONCLUSION

This paper shows an ongoing project on the development of a DSS for ERP systems evaluation in SMEs. The ERP systems selection is a important issue for SMEs in Venezuela and around the world. The proposed DSS allows to build an AHP hierarchy and carry out the remaining phases of the AHP method. The DSS can be a effective tool for help SMEs managers in Venezuela to acomplish succesfully the ERP selection task.

ACKNOWLEDGEMENTS

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