SELECTING THE SUITABLE ERP SYSTEM: A FUZZY AHP APPROACH

Ufuk Cebeci

Department of Industrial Engineering, Istanbul Technical University,
Macka, Istanbul 34367, Turkey
90 - 212 2931300
ufuk_cebeci@yahoo.com

Abstract *An Enterprise Resource Planning System (ERP) is the information backbone of a company that integrates and automates all facets of business operations. It is a critical issue to select the suitable ERP system which meets all the business strategies and the goals of the company. This study presents an analytical tool for selecting the suitable ERP system. This ERP selection method was applied in a textile manufacturing company. At first, the criteria were determined by the internal evaluation team of the company and then compared according to their importance. Five ERP system solutions were selected to evaluate by the same team. An external evaluation team consisting of three ERP consultants was assigned to select one of these solutions according to the predetermined criteria. In this study, the fuzzy analytic hierarchy process, a fuzzy extension of the multi-criteria decision making technique AHP, was used to compare these ERP system solutions.*

Keywords*: ERP System, Fuzzy AHP, Decision making, textile*

1. Introduction

ERP systems are becoming more necessary for almost every firm to improve the competitiveness. According to the success of the implementation of ERP system; companies can obtain a competitive advantage in the global market rapidly. Over the past decade, many ERP projects have resulted in substantial tangible and intangible improvements in a variety of areas for the organizations (Davenport, 2000; Umble et al., 2003 and Yusuf et al., 2004). However, there are a number of examples where organizations were not successful in reaping the potential benefits that motivated them to make large investments in ERP implementations (Davenport, 2000 and Umble et al., 2003).

Implementations of ERP systems are one of the most difficult investment projects because of the complexity, high cost and adaptation risks. Companies have spent billions of dollars and used numerous amounts of man-hours for installing elaborate ERP software systems (Yusuf et al., 2004). A successful ERP project involves selecting an ERP software system and co-operative vendor, implementing this system, managing business processes change and examining the practicality of the system (Wei & Wang, 2002).

Determining the best ERP software that fits with the organizational necessity and criteria, is the first step of tedious implementation process. Hence, selecting a suitable ERP system is an extremely difficult and critical decision for managers. An unsuitable selection can significantly affect not only the success of the implementation but also performance of the company. However, many companies install their ERP systems hurriedly without fully understanding the implications for their business or the need for compatibility with overall organizational goals and strategies (Hicks & Stecke, 1995). The result of this hasty approach is failed projects or weak systems whose logic conflicts with organizational goals. This paper aims to provide an analytical tool to select the most suitable ERP software.

Kumar et al., (2003) investigated the key considerations and successful strategies in ERP implementation projects. Byun (2000) explored the use of AHP for deciding on car purchase. Wei et al., (2004) proposed a comprehensive framework for selecting a suitable ERP system based on an AHP-based decision analysis process. Cebeci and Kahraman (2002) compared some catering firms using four attributes and fuzzy AHP. The AHP is one of the extensively used multi-criteria decision-making methods. One of the main advantages

of this method is the relative ease with which it handles multiple criteria. In addition to this, AHP is easier to understand and it can effectively handle both qualitative and quantitative data.

The organization of this paper is as follows. First fuzzy sets and fuzzy numbers are introduced because our comparison method, fuzzy AHP, includes fuzzy numbers and their fuzzy algebraic operations. Then, a comparison among five ERP vendors is made by using fuzzy AHP for a work wear firm.

2. Fuzzy sets and fuzzy numbers

To deal with vagueness of human thought, Zadeh (1965) first introduced the fuzzy set theory, which was oriented to the rationality of uncertainty due to imprecision or vagueness. A major contribution of fuzzy set theory is its capability of representing vague data. The theory also allows mathematical operators and programming to apply to the fuzzy domain. A fuzzy set is a class of objects with a continuum of grades of membership. Such a set is characterized by a membership (characteristic) function, which assigns to each object a grade of membership ranging between zero and one. Zimmermann (1994) gives the algebraic operations with Triangular Fuzzy Numbers (TFNs). Many ranking methods for fuzzy numbers have been developed in the literature. They do not necessarily give the same rank. The algebraic operations with fuzzy numbers can be found in Kahraman (2001) and Kahraman et al. (2002).

3. Case Study

In this study a Fuzzy AHP is developed to select the appropriate ERP software for a medium-size Turkish work wear (textile) firm. The textile industry is one of the most important industries for export in Turkey. Nowadays, the companies have to decrease the costs to improve competitiveness. The firm Ismont is leader in work wear. It is very important to manage to manage their supply chain, customer orders and costs. The firm should select an appropriate ERP package fast, because the present information system cannot support their needs.

The AHP model provides priority weights for the ERP packages, based on the ERP project team's preferences on multiple criteria. The alternative with the highest priority weight is then selected for the firm (Figure 1).

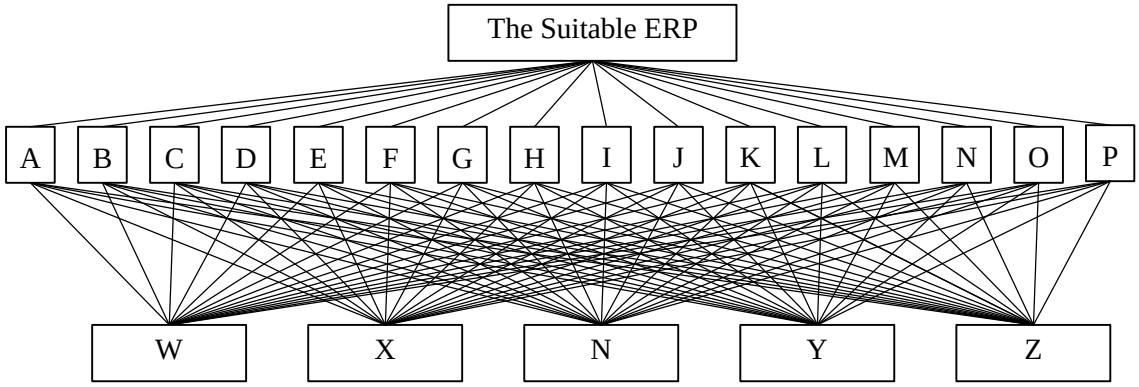

Figure 1. The AHP model

The attributes were determined according to the managers' opinions, organizational goals and literature:

I. Ease in customizing the system
J. Cross module integration
K. User friendliness
L. Compatibility with other systems
M. Total cost
N. Better fit with company's business processes
O. Implementation time
P. Decision Support System Opportunity
Q. Functionality
R. Adaptation to CRM and SCM systems
S. Flexibility
T. Web based applications support
U. Upgrade ability
V. After sales service
W. Systems reliability
X. Vendor reputation

Some questionnaires aiming at determining the degrees of preference by the help of the pair wise comparisons among the attributes are prepared. The questionnaires facilitate the answering of pair wise comparison questions. The ERP project team consists of a director, two IT experts and a consultant, compared the five ERP software and vendors with respect to each attributes. The meanings of the attributes were explained in detail to every one in project team so that every one would understand the same thing when they read the questionnaire. The matrix of paired comparisons for attributes is given in Table 1. After assigning the weights to each attribute, the project team compared all ERP alternatives; W, X, N, Y and Z. The matrix of paired comparisons for alternatives is given in Table 2. Summary of priority weights label as attribute weights is given in Table 3 and after applying the methodology, MBS NAVISION with Pebblestone (N) is selected.

Table 1. The matrix of paired comparisons for attributes

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
A	1,000	3,000	1,000	5,000	7,000	3,000	7,000	7,000	5,000	5,000	5,000	7,000	5,000	3,000	5,000	3,000
B	0,333	1,000	3,000	3,000	5,000	3,000	5,000	5,000	7,000	5,000	5,000	7,000	5,000	7,000	5,000	5,000
C	1,000	0,333	1,000	3,000	3,000	1,000	3,000	3,000	5,000	5,000	1,000	5,000	5,000	5,000	5,000	3,000
D	0,200	0,333	0,333	1,000	3,000	1,000	3,000	1,000	3,000	1,000	1,000	3,000	3,000	5,000	5,000	3,000
E	0,143	0,200	0,333	0,333	1,000	0,333	3,000	1,000	1,000	0,333	1,000	3,000	0,330	1,000	1,000	0,330
F	0,333	0,333	1,000	1,000	3,000	1,000	3,000	5,000	1,000	1,000	1,000	3,000	3,000	3,000	1,000	1,000
G	0,143	0,200	0,333	0,333	0,333	0,333	1,000	1,000	0,333	1,000	3,000	1,000	1,000	3,000	3,000	3,000
H	0,143	0,200	0,333	1,000	1,000	0,200	1,000	1,000	0,333	0,200	0,333	1,000	1,000	1,000	0,330	1,000
I	0,200	0,143	0,200	0,333	1,000	1,000	3,000	3,000	1,000	1,000	1,000	1,000	1,000	0,330	0,330	1,000
J	0,200	0,200	0,200	1,000	3,000	1,000	1,000	5,000	1,000	1,000	3,000	1,000	0,330	1,000	0,333	1,000
K	0,200	0,200	1,000	1,000	1,000	1,000	0,333	3,000	1,000	0,333	1,000	3,000	1,000	1,000	1,000	3,000
L	0,143	0,143	0,200	0,333	0,333	0,333	1,000	1,000	1,000	1,000	0,333	1,000	0,330	0,333	0,200	0,330
M	0,200	0,200	0,200	0,333	3,030	0,333	1,000	1,000	1,000	3,030	1,000	3,030	1,000	0,330	0,200	1,000
N	0,333	0,143	0,200	0,200	1,000	0,333	0,333	1,000	3,030	1,000	1,000	3,000	3,030	1,000	0,330	0,330
O	0,200	0,200	0,200	0,200	1,000	1,000	0,333	3,030	3,030	3,000	1,000	5,000	5,000	3,030	1,000	3,000
P	0,333	0,200	0,333	0,333	3,030	1,000	0,333	1,000	1,000	1,000	0,333	3,030	1,000	3,030	0,333	1,000

Table 2. The matrix of paired comparisons for alternatives

Total cost

	W	X	N	Y	Z	Total	Avr
W	0,059	0,057	0,049	0,059	0,027	**0,251**	**0,050**
X	0,412	0,402	0,728	0,412	0,135	**2,089**	**0,418**
N	0,176	0,080	0,146	0,176	0,676	**1,255**	**0,251**
Y	0,059	0,057	0,049	0,059	0,027	**0,251**	**0,050**
Z	0,294	0,402	0,029	0,294	0,135	**1,155**	**0,231**
Total	1,000	1,000	1,000	1,000	1,000	5,000	1,000

Implementation time

	W	X	N	Y	Z	Total	Avr
W	0,053	0,116	0,027	0,027	0,051	**0,273**	**0,055**
X	0,158	0,349	0,398	0,405	0,356	**1,666**	**0,333**
N	0,263	0,116	0,133	0,243	0,119	**0,874**	**0,175**
Y	0,158	0,070	0,044	0,081	0,119	**0,472**	**0,094**
Z	0,368	0,349	0,398	0,243	0,356	**1,715**	**0,343**
Total	1,000	1,000	1,000	1,000	1,000	5,000	1,000

Functionality

	W	X	N	Y	Z	Total	Avr
W	0,382	0,382	0,556	0,299	0,304	**1,923**	**0,385**
X	0,055	0,055	0,037	0,060	0,130	**0,336**	**0,067**
N	0,127	0,273	0,185	0,299	0,217	**1,102**	**0,220**
Y	0,382	0,273	0,185	0,299	0,304	**1,443**	**0,289**
Z	0,055	0,018	0,037	0,043	0,043	**0,196**	**0,039**
Total	1,000	1,000	1,000	1,000	1,000	5,000	1,000

Flexibility

	W	X	N	Y	Z	Total	Avr
W	0,053	0,032	0,057	0,143	0,041	**0,325**	**0,065**
X	0,263	0,161	0,283	0,143	0,096	**0,946**	**0,189**
N	0,263	0,161	0,283	0,429	0,288	**1,424**	**0,285**
Y	0,053	0,161	0,094	0,143	0,288	**0,739**	**0,148**
Z	0,368	0,484	0,283	0,143	0,288	**1,566**	**0,313**
Total	1,000	1,000	1,000	1,000	1,000	5,000	1,000

Upgrade ability

	W	X	N	Y	Z	Total	Avr

Systems reliability

	W	X	N	Y	Z	Total	Avr

W	0,374	0,368	0,542	0,283	0,349	**1,916**	**0,383**		**W**	0,283	0,484	0,238	0,283	0,176	**1,464**	**0,293**
X	0,053	0,053	0,060	0,057	0,023	**0,246**	**0,049**		**X**	0,057	0,097	0,238	0,094	0,176	**0,662**	**0,132**
N	0,125	0,158	0,181	0,283	0,349	**1,095**	**0,219**		**N**	0,283	0,097	0,238	0,283	0,294	**1,195**	**0,239**
Y	0,374	0,263	0,181	0,283	0,209	**1,310**	**0,262**		**Y**	0,283	0,290	0,238	0,283	0,294	**1,389**	**0,278**
Z	0,075	0,158	0,036	0,094	0,070	**0,433**	**0,087**		**Z**	0,094	0,032	0,048	0,057	0,059	**0,290**	**0,058**
Total	1,000	1,000	1,000	1,000	1,000	5,000	1,000		**Total**	1,000	1,000	1,000	1,000	1,000	5,000	1,000
User friendliness									**Ease in customizing the system**							
	W	**X**	**N**	**Y**	**Z**	**Total**	**Avr**			**W**	**X**	**N**	**Y**	**Z**	**Total**	**Avr**
W	0,105	0,184	0,107	0,068	0,294	**0,757**	**0,151**		**W**	0,120	0,111	0,091	0,231	0,158	**0,711**	**0,142**
X	0,035	0,061	0,076	0,041	0,176	**0,390**	**0,078**		**X**	0,360	0,333	0,273	0,231	0,474	**1,671**	**0,334**
N	0,523	0,429	0,533	0,617	0,294	**2,395**	**0,479**		**N**	0,360	0,333	0,273	0,231	0,158	**1,355**	**0,271**
Y	0,317	0,306	0,178	0,206	0,176	**1,183**	**0,237**		**Y**	0,040	0,111	0,091	0,077	0,053	**0,372**	**0,074**
Z	0,021	0,020	0,107	0,069	0,059	**0,275**	**0,055**		**Z**	0,120	0,111	0,273	0,231	0,158	**0,893**	**0,179**
Total	1,000	1,000	1,000	1,000	1,000	5,000	1,000		**Total**	1,000	1,000	1,000	1,000	1,000	5,000	1,000
Cross module integration									**Compatibility with other systems**							
	W	**X**	**N**	**Y**	**Z**	**Total**	**Avr**			**W**	**X**	**N**	**Y**	**Z**	**Total**	**Avr**
W	0,366	0,405	0,176	0,616	0,294	**1,858**	**0,372**		**W**	0,382	0,412	0,181	0,642	0,333	**1,949**	**0,390**
X	0,073	0,081	0,059	0,068	0,176	**0,458**	**0,092**		**X**	0,055	0,059	0,060	0,043	0,048	**0,264**	**0,053**
N	0,366	0,243	0,176	0,068	0,176	**1,031**	**0,206**		**N**	0,382	0,176	0,181	0,071	0,238	**1,048**	**0,210**
Y	0,122	0,243	0,529	0,205	0,294	**1,394**	**0,279**		**Y**	0,127	0,294	0,542	0,214	0,333	**1,511**	**0,302**
Z	0,073	0,027	0,059	0,041	0,059	**0,259**	**0,052**		**Z**	0,055	0,059	0,036	0,031	0,048	**0,228**	**0,046**
Total	1,000	1,000	1,000	1,000	1,000	5,000	1,000		**Total**	1,000	1,000	1,000	1,000	1,000	5,000	1,000
Better fit with company's business processes									**Decision Support System Opportunity**							
	W	**X**	**N**	**Y**	**Z**	**Total**	**Avr**			**W**	**X**	**N**	**Y**	**Z**	**Total**	**Avr**
W	0,130	0,360	0,152	0,040	0,273	**0,955**	**0,191**		**W**	0,484	0,273	0,568	0,556	0,238	**2,118**	**0,424**
X	0,043	0,120	0,152	0,360	0,091	**0,766**	**0,153**		**X**	0,097	0,055	0,027	0,037	0,143	**0,358**	**0,072**
N	0,391	0,360	0,455	0,360	0,455	**2,020**	**0,404**		**N**	0,161	0,382	0,189	0,185	0,333	**1,251**	**0,250**
Y	0,391	0,040	0,152	0,120	0,091	**0,794**	**0,159**		**Y**	0,161	0,273	0,189	0,185	0,238	**1,046**	**0,209**
Z	0,043	0,120	0,091	0,120	0,091	**0,465**	**0,093**		**Z**	0,097	0,018	0,027	0,037	0,048	**0,227**	**0,045**
Total	1,000	1,000	1,000	1,000	1,000	5,000	1,000		**Total**	1,000	1,000	1,000	1,000	1,000	5,000	1,000
Adaptation to CRM and SRM systems									**Web based applications support**							
	W	**X**	**N**	**Y**	**Z**	**Total**	**Avr**			**W**	**X**	**N**	**Y**	**Z**	**Total**	**Avr**
W	0,374	0,263	0,542	0,299	0,382	**1,860**	**0,372**		**W**	0,273	0,273	0,283	0,283	0,200	**1,311**	**0,262**
X	0,075	0,053	0,060	0,043	0,018	**0,249**	**0,050**		**X**	0,091	0,091	0,094	0,094	0,067	**0,437**	**0,087**
N	0,125	0,158	0,181	0,299	0,273	**1,035**	**0,207**		**N**	0,273	0,273	0,283	0,283	0,333	**1,445**	**0,289**
Y	0,374	0,368	0,181	0,299	0,273	**1,495**	**0,299**		**Y**	0,273	0,273	0,283	0,283	0,333	**1,445**	**0,289**
Z	0,053	0,158	0,036	0,060	0,055	**0,362**	**0,072**		**Z**	0,091	0,091	0,057	0,057	0,067	**0,362**	**0,072**
Total	1,000	1,000	1,000	1,00	1,00	5,00	1,000		**Tota**	1,00	1,00	1,000	1,00	1,00	5,00	1,000

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After sales service									**Vendor reputation**								
	W	**X**	**N**	**Y**	**Z**	**Total**	**Avr**			**W**	**X**	**N**	**Y**	**Z**	**Total**	**Avr**
W	0,283	0,333	0,333	0,391	0,120	**1,461**	**0,292**		**W**	0,550	0,313	0,409	0,755	0,304	**2,331**	**0,466**
X	0,057	0,067	0,111	0,043	0,040	**0,318**	**0,064**		**X**	0,079	0,045	0,019	0,022	0,130	**0,295**	**0,059**
N	0,283	0,200	0,333	0,391	0,360	**1,568**	**0,314**		**N**	0,183	0,313	0,136	0,050	0,217	**0,901**	**0,180**
Y	0,094	0,200	0,111	0,130	0,360	**0,896**	**0,179**		**Y**	0,110	0,313	0,409	0,151	0,304	**1,287**	**0,257**
Z	0,283	0,200	0,111	0,043	0,120	**0,758**	**0,152**		**Z**	0,079	0,015	0,027	0,022	0,043	**0,186**	**0,037**
Total	1,000	1,000	1,000	1,000	1,000	5,000	1,000		**Total**	1,000	1,000	1,000	1,000	1,000	5,000	1,000

Table 3. Summary of priority weights label as attribute weights

Alternatives	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Total**
W	0,009	0,009	0,043	0,005	0,012	0,019	0,006	0,003	0,013	0,017	0,009	0,008	0,013	0,009	0,017	0,018	**0,210**
X	0,075	0,055	0,008	0,013	0,002	0,008	0,003	0,008	0,003	0,002	0,007	0,001	0,002	0,003	0,004	0,002	**0,197**
N	0,045	0,029	0,025	0,020	0,007	0,015	0,020	0,007	0,007	0,009	0,018	0,005	0,007	0,010	0,019	0,007	**0,250**
Y	0,009	0,016	0,033	0,011	0,008	0,018	0,010	0,002	0,010	0,013	0,007	0,004	0,011	0,010	0,011	0,010	**0,180**
Z	0,042	0,056	0,004	0,022	0,003	0,004	0,002	0,004	0,002	0,002	0,004	0,001	0,003	0,002	0,009	0,001	**0,162**

4. Conclusion

ERP systems have a vital role in today's organizations. However, they have also high costs and high implementation risks. Decisions are made today in increasingly complex environments. In more and more cases the use of experts in various fields is necessary, different value systems are to be taken into account, etc. In many of such decision-making settings the theory of fuzzy decision-making can be of use. Fuzzy group decision-making can overcome this difficulty. In general, many concepts, tool and techniques of artificial intelligence, in particular in the field of knowledge representation and reasoning, can be used to improve human consistency and implementability of numerous models and tools in broadly perceived decision-making and operations research.

In this paper, ERP packages and vendors were compared using fuzzy AHP. Humans are often uncertain in assigning the evaluation scores in crisp AHP. Fuzzy AHP can capture this difficulty. However, Fuzzy AHP cannot support all phases of ERP selection and implementation. Hence, a decision support system or expert system can be added when gathering data for selection process. Also, the expert system can be used before and after the ERP system selected. The lessons from this textile firm case or other applications can be added into the knowledgebase of the expert system. The expert system can help to prepare A Request for Proposal for a textile firm. Because this stage needs experience about the selection process.

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