

# Strategic Decision Making for Outsourcing Information Systems with a Fuzzy Multi-criteria Decision-Making Approach

<sup>1</sup>Mahmoud Modiri\*, <sup>2</sup>Mohammad Dashti

<sup>1</sup>Assistant Professor, Department of Management, Tehran South Branch, Islamic Azad University, Tehran, Iran

<sup>2</sup>Department of Management, Science and Research Branch, Islamic Azad University, Tehran, Iran

## Abstract—

**T**oday, IS supplier selection is one of the most critical steps in the outsourcing process; the success of outsourcing is highly dependent on the selection of IS suppliers. This paper proposes a new hybrid fuzzy multi-criteria decision-making (MCDM) model, which uses decision-making trial and evaluation laboratory (DEMATEL) technique, analytic network process (ANP), and Vlse Kriterijumska Optimizacija I Kompromisno Resenje (VIKOR) to evaluate four potential suppliers using seven factors and five decision makers using a realistic case study. The results showed that Service support is importance for outsourcing. The proposed model can help practitioners improve their decision making process.

**Keywords—** outsourcing information systems, DEMATEL, ANP, VIKOR, Fuzzy.

## I. INTRODUCTION

Today, many organizations decide to take advantage of work in the global market, especially in the process of outsourcing the organization's activities and deciding how to do it (Koschitzki et al, 2006). Because of the role of the information systems strategy as a factor supporting the organization's strategic decisions, the acquisition of advanced and advanced competitive technologies, many organizations have decided to outsource this system (Chen et al, 2011). The evolution of outsourcing Information Technology (IT) Services has been accompanying the movement of technological innovations and the changes in IT governance. This development has motivated organizations to conduct decision-making integrating preferences from managers of different sectors in the Enterprise in order to improve the decision process (Morais et al, 2014)

Outsourcing has become a common strategy in the information system/information technology (IS/IT) field in recent years. Many organizations attempt to enhance their competitiveness, reduce costs, increase their focus on internal resources and core activities, and sustain competitive advantage by IS/IT outsourcing. Selection of appropriate outsourcing partners is an extremely important goal for organizations (Chen et al, 2011). One of the most outsourcing practices is information system/information technology (IS/IT) outsourcing (Chen et al, 2011). The outsourcing decision is important since the correct selection can dramatically increase a firm's performance (Kahraman et al, 2010).

Outsourcing of information systems is a strategic way to balance technology and business goals, as well as a way to reduce operating costs in today's complex business environment (Lacity et al. 2009). But most organizations have failed to achieve their outsourcing goals (Chen et al, 2011). nowadays the most difficult process is how to decide in order to choose an alternative for outsourcing IT service within an Enterprise, taking into account the points of view from different managers. supporting a group decision-making becomes intensely difficult due to the presence of multiple actors each with their own perceptions of the way the problem should be handled and the decision made (Matsatsinis et al, 2005)

How to make scientific IS outsourcing decisions is an important problem. If the outsourcing of information systems is not done properly, it will cost a lot to the organization. And the organization will lose its competitive advantage and business capabilities. A company whose main activity is the design, implementation, and control of industrial projects; it plans to outsource its information systems. The purpose of this research is to help companies outsource information systems. The organization intends to rank and select information systems companies according to their strategic goals. The choice of companies should be based on factors. Fuzzy MCDM methods are suitable for weighting and prioritizing factors, which are used in this research. The questions are as follows:

1. What are the factors influencing strategic decision making for outsourcing of information systems?
2. What are the relationships and effects between factors?
3. How to prioritize strategic decision-making evaluation factors in outsourcing information systems
4. What is the ranking and selection of the most suitable company for outsourcing of information systems?

## II. LITERATURE REVIEW

Outsourcing can be defined as 'an act of moving some of a firm's internal activities and decision responsibilities to outside providers', as 'the procurement of products and services from sources that are external to the organization, or as 'allocating or reallocating business activities (both service and/or manufacturing) from an internal source to an external source (Kahraman et al, 2010).

Outsourcing has become a common practice since the 1980s. Outsourcing became very popular in the 1990s, encouraged by success such as Eastman Kodak's externalisation of information systems (ISs) (Kahraman et al, 2010). Outsourcing typically transfers production functions of goods or services to external providers (Araz et al 2007). Outsourcing is defined as ongoing purchasing of services and parts from an outside company that is already provided by the outsourcing company (Linder, 2004).

Outsourcing can be simply defined as devising a contract with an external organization to take primary responsibility for providing certain business processes (Yang et al, 2007). Business outsourcing has become an ever-increasing trend in today's highly competitive markets. Firms can either embark on internal off-shoring (by setting up their own centers or subsidiaries in foreign countries while maintaining full ownership and control) or external off-shoring (by handing over business functions to independent foreign providers). Interest is growing among strategy and international business scholars to better understand how outsourcing can be used as a strategic device, or sometimes as a strategy itself, in order to create value (Kedia & Mukherjee, 2009)

Outsourcing occurs when one company contracts with another to hand over a part of their existing internal activity (McCarthy & Anagroustou, 2004). The purpose of outsourcing is to create value from the outside, rather than within, the company. Outsourcing has become an important business approach, gaining competitive advantages when products or services are produced more efficiently by outside suppliers (Yang et al, 2007). Dhar and Balakrishnan (2006) indicated that IS/IT outsourcing can transfer some or all of IS/IT-related decision-making rights, business processes, internal activities, and services to external providers, which can more effectively manage time and costs, and improve productivity, quality, and customer satisfaction. Many studies have analysed the reasons most often leading to IS outsourcing.

Outsourcing is the practice of using a vendor rather than in-house employees to perform a function. This practice will most likely continue and potentially increase as firms look to consolidate and focus on their core business activities (Fill & Visser, 2000). number of decision frameworks appear in academic literature to support the outsourcing decision-making process. Outsourcing is often strictly a cost decision, driven by the firm's goal to maximize profitability. For some outsourcing endeavors, such as information technology (IT) outsourcing, the type of work should also be considered (Grover & Teng, 1993). Their decision-tree model differentiates IT work into two categories, the systems level and the impact level. The model is not quantified, but does provide insight into the go/no go outsourcing decision. Another analytic model designed to support the go/no go outsourcing decision considers several criteria in the decision process, including the context of the function that is being considered for outsourcing, the overall strategy and structure of the outsourcer firm, and costs associated with outsourcing (Fill & Visser, 2000). A decision support model that draws on operations research techniques considers vendor selection and negotiation (Weber et al, 2000). This paper has a 'partnership pyramid' that identifies five stages of the vendor selection: analyze the decision environment, identify options, evaluate/compare options, negotiate, and form partnerships. The paper outlines a multi-objective programming model that aids in vendor selection. Vokurka, Choobineh and Vadi (1996) formulate a prototype expert system to support the supplier selection decision and demonstrate applicability of the system by applying it to a manufacturing case study.

Claver, Gonzalez, Gasco, and Llopis (2002) identified the following reasons for IS outsourcing: reducing costs; increasing the flexibility of the IS department; focusing on IS strategic issues; eliminating troublesome, everyday problems; reducing technology costs; improving IS quality; increasing access to new technologies; and, decreasing risk. In sum, most organizations seek to improve their competitiveness, reduce costs, focus internal resources on core activities, and sustain their competitive advantage by IS/IT outsourcing (Parry et al, 2006).

Early researchers most commonly utilized the transaction cost theory to illustrate outsourcing decisions. However, in recent years, strategy aspects related to core competency, risk analysis and organizational flexibility have been growing in importance. As a result, this trend has led researchers and industries to become more interested in the multi-criteria decision model for outsourcing. The goal of the multiple criteria decision-making (MCDM) method is to aid decision-makers to integrate objective measurements with value judgments not based on individual opinions, but rather on collective group ideas (Belton & Stewart, 2002). Some have striven to apply the MCDM method to different outsourcing issues (Wang & Yang, 2007), but have assumed the criteria to be independent, using the analytic hierarchical process (AHP) to construct a model of the outsourcing problem. In the real world, criteria are seldom independent and always have a degree of interactive relationships, sometimes with dependence and feedback effects (Tsai & Chou, 2009).

In this study, we use the DEMATEL method to construct the interrelationship between criteria, as well as the ANP method (which releases the restriction of the hierarchical structure) to determine the weights of the criteria. However, due to problems such as incomplete information and subjective uncertainty, even experts find it difficult to quantify the precise ratio of weights for the different criteria. The concept of fuzzy sets has been incorporated into AHP to deal with the problem of uncertainty, although ANP has not often been used to address this type of problem in fuzzy environments. A way to cope with uncertain judgments and to incorporate the vagueness that typifies human thinking is to express preferences as fuzzy sets or fuzzy numbers (Liou et al, 2011). To deal with complex decision-making problems, fuzzy logic or a fuzzy set is a systematic way of defining a particular knowledge domain by handling uncertainty, vague situations, and imprecise information by emulating skilled humans when conventional mathematics is ineffective. Some researchers have applied fuzzy multi-criteria decision-making (FMCDM) methods in the field of IS outsourcing (Chen et al, 2011).

for example, a fuzzy group decision-making methodology based on TOPSIS for IS outsourcing provider selection for the largest office furniture manufacturer (Kahraman et al, 2009), fuzzy VIKOR for IS outsourcing provider selection for a Taiwan-based computer manufacturer (Chen and Wang, 2009), Strategic decisions using the fuzzy PROMETHEE for IS outsourcing (Chen et al, 2011).

### III. RESEARCH METHODOLOGY

Since the organization intends to use the results of this research, the type of research is applied on the basis of the goal. The statistical population of the research is the experts in the information system of the Consulting Engineers Company. The group of experts consists of two groups: the first group consists of 15 senior experts selected for screening and selecting identified factors. The second group was also selected as 5 experts. Experts to study this issue were fully aware. A questionnaire was used to collect data. The validity of the questionnaire was confirmed by the university professors. The scattering of experts' answers was done for the reliability of the questionnaire. Fuzzy MCDM method was used to analyze the data. Due to the relationship between factors, the ANP method was used for weighting. The DEMATEL method was used to determine the relationships and effectiveness, and the VIKOR method was used to rank companies for outsourcing. DEMATEL, according to the concrete characteristics of objective affairs, can confirm the interdependence between the variables/factors and limit relations that reflect characteristics. With essential system and development trends (Liou et al, 2007). Respondents were asked to indicate the direct effect that they believe each element  $i$  exerts on each element  $j$  of others, as indicated by  $a_{ij}$ , using an integer scale (scores) ranging from 0 to 4: "no influence (0)"; "low influence (1)"; "medium influence (2)"; "high influence (3)"; and "very high influence (4)" (Liou et al, 2011).

The ANP is a new theory extended from the AHP, proposed by Saaty to overcome the problem of interdependence and feedback between criteria or alternatives. The weights of the influence of each criterion are obtained by  $\lim_{K \rightarrow \infty} (W^{\alpha})^K$  (Saaty, 2008). We use these processes to obtain the weights of influence.

The fuzzy VIKOR method has been developed to solve fuzzy multicriteria problem with conflicting and non-commensurable (different units) criteria. Fuzzy VIKOR is based on the aggregating fuzzy merit that represents distance of an alternative to the ideal solution (Opricovic, 2011). The steps in the above methods are fully described in the sources mentioned.

### IV. FINDINGS

The Company selection criteria were developed on the basis of a literature review and a series of discussions with managers. This discussion with the industry helped us to classify the various factors of decision-making into Seven factors. These factors were then divided into various sub-factors, That were screened and selected, as indicated in Table 1.

Table I Factors Affecting Strategic Decision Making for Outsourcing of Information Systems

Factors	Sub-Factors
Strategic importance $C_1$	The supplier's share in achieving the main objectives of the organization
	The rate of use of the supplier from the strategic resources of the organization
	The importance of the supplier for the future of the organization
Details supplier $C_2$	The degree of assurance to the supplier
	Provider Organizational Capabilities
	flexibility
Risk $C_3$	Loss of internal technical knowledge
	Losing important skills and abilities
	Loss of merit
Quality $C_4$	Improving the quality of the internal MIS services
	Essential Standards
	Service support
Financial $C_5$	Saving on operational costs and overhead costs
	Financial performance
	Price
Delivery $C_6$	Lead Time
	Delivery time
	Response time
Technology $C_7$	The ability of information systems
	Specialty and technical skills
	Technology capabilities

Managers were asked to score the relationships among factors. The average initial direct-relation matrix is a  $7 \times 7$  matrix obtained by pairwise comparisons in terms of influences and directions between factors, as shown in Table 2. Then, the total influence matrix  $T$  is derived. Also, the sum of influence given to and received by each factors and sub-factors is calculated with the results shown in Table 3. The  $D_i + R_i$  value represents the total influence levels, and  $D_i - R_i$  represents net influence levels, where the positive values indicate that it will influence other factors. more than other factors. influence it. Table 4 indicates that Strategic importance has the largest net influence levels. According to the results of DEMATEL, the IRM of the DEMATEL method is obtained and shown in Fig. 1.

Table II Initial influence matrix

	C <sub>1</sub>			C <sub>2</sub>			C <sub>5</sub>			C <sub>...</sub>	C <sub>6</sub>			C <sub>7</sub>		
	L	M	U	L	M	U	L	M	U	...	L	M	U	L	M	U
C <sub>1</sub>	0	0	0	0.75	1	1	0.63	0.88	1	...	0.75	1	1	0.63	0.88	1
C <sub>2</sub>	0.63	0.88	1	0	0	0	0.38	0.63	0.88	...	0.75	1	1	0.63	0.88	1
C <sub>3</sub>	0.63	0.88	1	0.38	0.63	0.88	0.75	1	1	...	0.38	0.63	0.88	0.13	0.38	0.63
C <sub>4</sub>	0.13	0.38	0.63	0.13	0.38	0.63	0.75	1	1	...	0.38	0.63	0.88	0	0.13	0.38
C <sub>5</sub>	0.38	0.63	0.88	0.38	0.63	0.88	0	0	0	...	0.13	0.38	0.63	0.38	0.63	0.88
C <sub>6</sub>	0.38	0.5	0.63	0.75	1	1	0.38	0.63	0.88	...	0	0	0	0	0.13	0.38
C <sub>7</sub>	0.13	0.38	0.63	0	0.13	0.38	0.38	0.63	0.88	...	0.63	0.88	1	0	0	0

Table III Initial influence matrix

Factors	$\tilde{D}$	$\tilde{R}$	$\tilde{D} + \tilde{R}$	$\tilde{D} - \tilde{R}$
Strategic	4.613	3.397	8.01	1.216
Details supplier	4.253	3.463	7.716	0.79
Risk	3.905	4.303	8.207	-0.4
Quality	2.987	4.225	7.212	-1.24
Financial	3.671	4.178	7.849	-0.51
Delivery	3.498	3.863	7.362	-0.36
Technology	3.364	2.862	6.225	0.502

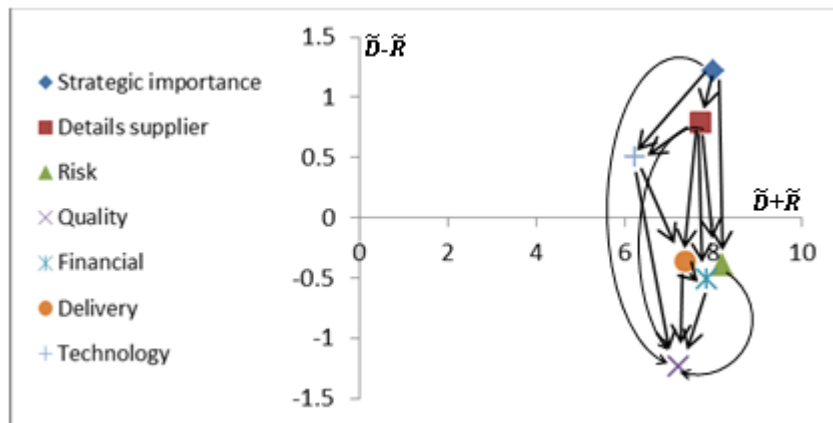


Fig.1 Impact relationship map (IRM).

After determining the relationship structure between the factors of the evaluated systems, the ANP method is applied to derive the weights of the criteria. The unweighted super-matrix was constructed using Total influence matrix in DEMATEL. The weighted super-matrix was constructed to reflect the degrees of influence exerted by various factors and sub-factors. The limiting power of the weighted super-matrix was used to reach a long-term stable condition. Table 4 represents the global and local weights of various of various factors and sub-factors. As Table 4 shows, the most weight is the factor of "Service support" that got the first priority.

Table IV Importance weights of evaluation Factors and sub factors

Global weight and priority	Local weight and priority	Global weight and priority
Strategic importance (6)	0.3231 (3)	0.0416 (16)
	0.3491 (1)	0.045 (12)
	0.3278 (2)	0.0422 (14)
Details supplier (5)	0.3192 (3)	0.042 (15)
	0.355 (1)	0.0467 (11)
	0.3258 (2)	0.0428 (13)
Risk (1)	0.3551 (1)	0.0592 (2)
	0.3364 (2)	0.0561 (5)

		0.3084 (3)	0.0514 (9)
Quality	0.162 (3)	0.2465 (3)	0.0399 (18)
		0.3637 (2)	0.0588 (3)
		0.3898 (1)	0.063 (1)
Financial	0.164 (2)	0.3316 (2)	0.0545 (6)
		0.3509 (1)	0.0577 (4)
		0.3176 (3)	0.0522 (8)
Delivery	0.145 (4)	0.352 (2)	0.0512 (10)
		0.3685 (1)	0.0536 (7)
		0.2795 (3)	0.0406 (17)
Technology	0.102 (7)	0.355 (1)	0.036 (19)
		0.3121 (3)	0.0317 (21)
		0.3329 (2)	0.0338 (20)

We apply the fuzzy VIKOR method to determine the compromise rankings after calculating the influence weights for the criteria using fuzzy DANP. For evaluation Four IS outsourcing suppliers (A1, A2, A3 and A4) are proposed as feasible alternatives to be evaluated by five decision- Maker according to 21 decision sub-factors. The calculations were done to solve the fuzzy VIKOR and the result is shown in Table 1.

Table V The values of  $\tilde{Q}$ ,  $Q_j$ ,  $S_j$  and  $R_j$

	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>4</sub>
$\tilde{Q}$	(-0.874, 0.025, 1)	(-0.903, 0.032, 0.967)	(-0.948, 0.035, 0.991)	(-0.926, 0.052, 0.967)
$Q_j$	0.05 (4)	0.032 (3)	0.026 (1)	0.031 (2)
$S_j$	0.162 (4)	0.102 (1)	0.159 (3)	0.119 (2)
$R_j$	0.027 (3)	0.027 (4)	0.024 (1)	0.026 (2)

According to the values of  $\tilde{Q}$ ,  $\tilde{S}$  and  $\tilde{R}$  the ascending rank of these 5 hospitals is substituted as follows:

$$A_3 < A_4 < A_2 < A_1$$

This ascending rank suggests that the third (A<sub>3</sub>) company, with the minimum of  $Q_j$  and  $R_j$ , has the best company among these 5 companies

## V. CONCLUSIONS

This paper presented a group decision model for choosing an alternative of outsourcing IS service, based on the group decision-making rankings, in order to assist managers from different sectors in an Enterprise to achieve a solution judged appropriate. Interdependencies among factors are also considered through the DEMATEL method. Because of the diversity of judgments from decision-makers, we combined fuzzy ANP to decide the relative weights of each criterion given dependence and feedback.

Strategic importance ( $\tilde{D} - \tilde{R}$ ) has the largest positive, meaning that it is the most influential factor. Strategic importance plays a major role in the evaluation system and has the greatest actual impact on other factors. Quality has the least negative ( $\tilde{D} - \tilde{R}$ ) value and is thus most easily affected by other factors. As a result, decision makers can manage Strategic importance as a core consideration in outsourcing.

It is pertinent here to discuss the priority/weight values of the criteria, which influence this decision. It can be observed from Table 4 that Service support (6.3%) is the most important criterion for provider selection, followed by loss of internal technical knowledge (5.92%), Essential Standards (5.88%), and Financial performance (5.76%).

Then, the proposed fuzzy VIKOR for the presence of vagueness, uncertainty, and imprecision of information in the supplier selection problem. According to the results of fuzzy VIKOR, the third company has special privileges to outsource the information system and should be given priority because it has the characteristics and many basic factors for strategic decision-making for outsourcing of information systems.

Finally, it is suggested that future researchers explore outsourcing with other Fuzzy MCDM methods, FTOPSIS, GRA, and compare results.

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