A Fuzzy Scenario-Based Decision Aid for Risk Assessment in Business Process Outsourcing

Nazli Goker and Mehtap Dursun

***Abstract*—** Outsourcing ensures a great opportunity for firms to adopt flexible operation strategies and dynamic environment. Technological developments enable global companies to outsource more complex business processes due to the high cost of in-house operations. Business process outsourcing, which is considered to be a new big current in information systems services, is an improved version of information technologies outsourcing. This study introduces a scenario-based fuzzy cognitive map methodology (FCM) for assessing risk criteria in business process outsourcing. Since there are cause-and-effect relationships between pair of concepts, and the problem can be represented by a network, FCM technique becomes appropriate to evaluate the risk factors of business process outsourcing. The case study is conducted in a bank performing in Turkish banking sector. Several scenario analyses are employed to understand the influence of an increase or a decrease of the power of specific concept(s) on other concepts.

***Keywords*—**Outsourcing, business process, fuzzy cognitive map, risk assessment, scenario analyses

I. Introduction

Nowadays, companies concentrate on their core business processes. They focus on their expertise activities in order to keep up with increasing market competition, and to obtain competitive advantage. Herewith, firms have to buy certain business process services from the external firms for performing the peripheral activities of their business processes. This is the definition of business process outsourcing (BPO), which helps organizations achieve their business goals.

IT (information technologies) outsourcing has been a crucial part of strategic management. BPO is an improved version of IT outsourcing, which is considered to be a new big current in information systems services. One of the leader firms in IT consulting, called as "The Gartner Group" describes BPO as the assignment of one or more IT-enabled business processes to an external firm, which holds and manages the related process by taking into consideration the key performance indicators [1].

The BPO theme goes back a long way. Outsourcing service providers in fields such as location operations, accounting & finance, logistics services, marketing & sales, customer relationships have been in existence for a long time. However, changing and developing technology, and IT-intensive activities force companies to BPO. Also the BPO market is supposed to be changed and improved all the time because of the motivation for using technology, the development of Web services, and more cost-aware clients [1].

Notwithstanding many advantages that are thought to be offered from BPO, especially offshore BPO, outsourcers have to cope with important administrative and operational issues such as cultural and linguistic differences, problems that are related to contract signed between outsourcer and provider, risk of service quality reduction. Besides, when firms outsource more than one business process and work with multiple providers, managing all the BPO processes becomes more complicated because of the coordination difficulties and different locations [2].

Alternatively, BPO enables outsourcers for focusing on their core competencies while trusting in their overseas providers for specialized talents and capabilities. Due to the changing and developing technology, and then the pressure of the competitive dynamics of market, firms aim to build new enterprises, that are digitally allowed and extended, and that have access to specialized companies located in foreign countries. For instance, American Express Corporation has utilized India since 1990s to maintain its global BPO service activities, obtain yield from lower labor force and brain power costs, reach greater project management talents and develop IT services [2].

Conversely, BPO may cause several risk factors along with its potential benefits. Hence, positive and negative sides of BPO must be taken into account in the decision framework [3].

The risk factors include four main criteria such as performance, finance, strategy and psychology. Performance risk refers to the fact that the vendor does not provide the anticipated level of service. Financial risk supposes that the outsourcer has to pay more to obtain the anticipated level of service than expected in the beginning of cooperation. The client should take into consideration both its requirements and expectations. The outsourcer is exposed to the strategic risk when the outsourcer faces with losing some resources and skills that are required to maintain the competitiveness. These resources and skills may involve functional talents along with know-how, which is necessary to be innovative. In addition,

Nazli Goker is with the Industrial Engineering Department of Galatasaray University, Istanbul, Turkey (e-mail: nagoker@gsu.edu.tr).

Mehtap Dursun is with the Industrial Engineering Department of Galatasaray University, Istanbul, Turkey (corresponding author to provide phone: 00902122274480, e-mail: mdursun@gsu.edu.tr).

psychological risk is related to responsible manager's reputation and career when the business process is damaged because of the outsourcing [4].

Several authors have made a contribution to the BPO literature over the last decade. Yang et al. [1] determined the criteria affecting BPO and evaluated them with a MCDM approach. They employed a numerical illustration by using analytic hierarchy process (AHP) in human resources management. Balakrishnan et al. [5] implemented a mathematical programming model in order to identify the business processes that can be outsourced and the factors influencing the outsourcing decisions related to these processes. Gewald et al. [4] developed a BPO implication model based on risk-benefit analysis and testing it statistically in German banking industry. Narayanan et al. [6] focused on the issue of BPO integration and determined performance indicators by the service provider perspective. They used statistical tools. Chou et al. [7] analyzed statistically commitment criteria of the client in BPO.

Although BPO is crucial to outsourcers due to the risk and performance factors, which are mentioned in the previous part of this study, almost all the studies do not consider such a complex decision framework. In general, they do not provide any mathematical approach and evaluate BPO by social sciences perspective. A few studies employ statistical analysis, mathematical programming model or MCDM tool. However, these approaches do not consider the complexity of BPO decision framework. Hence, there is a gap in literature in the area of "evaluation of BPO process".

The objective of this study is to evaluate risk factors in BPO by using FCM methodology, which considers cause-and-effect relationships among the criteria and their directions namely positive and negative, and supporting the process by providing several scenario analyses.

The rest of the study is organized as follows. Section 2 explains FCM methodology. The following section illustrates the application of the proposed approach and scenario analyses. Section 4 delineates the concluding remarks and future research directions.

II. FCM METHODOLOGY

Fuzzy Cognitive Maps (FCMs), helping model complex decision systems, is a causal knowledge-based method which is originated from the combination fuzzy logic and neural networks [8]. Hereafter, Taber and Kosko [8,9] extended the method and included fuzzy numbers or linguistic variables for revealing the causal relationships among concepts in FCM. These concepts stand for an entity, a state, a variable or a characteristic of a system, a behavior of a knowledge-based system is represented by concepts in FCM [8].

Concept nodes and weighted arcs are the elements of FCM which can be graphically showed with feedback. Arcs are signed to understand the direction of causality: whether the causal relationship is positive, negative or null; and connect the nodes through which causal relationships among concepts are produced [10]. $C = \{C_1, C_2, ..., C_n\}$ is the representation of concepts set, arcs (C_j, C_i) demonstrate how concept C_j causes concept C_i, and are utilized for causal relationships between concepts.

The weights of causality links range in the interval [-1,1] or can be represented with linguistic variables such as "negatively weak", "zero", "positively weak", etc. The value of each concept is calculated, considering the effect of the other concepts on the under-evaluation concept, by applying the following iterative formulation.

$$A_i^{(k+1)} = f\left(A_i^{(k)} + \sum_{j=1}^{N}{}_{j\neq i} A_j^{(k)} w_{ji} \right) \quad (1)$$

where $A_i^{(k)}$ is the value of concept C_i at k^{th} iteration, w_{ji} is the weight of the connection from C_j to C_i and f is a threshold function.

The stepwise representation of the proposed methodology, which is illustrated in Figure 1, is provided below.

Step 1: *Determination of business process outsourcing risk factors:* In this study, weak management (C_1), agility (C_2), coordination (C_3), reliability (C_4), technological complexity (C_5), information accessibility (C_6), and employee productivity (C_7) are determined as BPO risk criteria through a literature survey and experts' opinions.

Step 2: *Signing causality links:* The experts determine the direction of causal relationships in three categories: positive, negative, null.

Step 3: *Fuzzification:* Experts decide the degree of causalities by using linguistic variables; subsequently linguistic variables are mapped to fuzzy numbers. In this study, nine linguistic terms are utilized such as negatively very strong (nvs), negatively strong (ns), negatively medium (nm), negatively weak (nw), zero (z), positively weak (pw), positively medium (pm), positively strong (ps), positively very strong (pvs), as shown in Table 1.

Step 4: *Obtaining the result of aggregation:* By means of MAX method, the outputs corresponding to each rule are transformed into a single fuzzy set, hereafter, this fuzzy number belonging to the interval [-1,1] is defuzzified by using Centre of Gravity (COG) method and is converted to a numerical value, w_{ji} .

Step 5: *Copy the matrix:* The process starts with the initial vector.

Step 6: *Check the matrix:* Updating the values of the initial vector is completed by applying Formulation (1) and a

threshold function. $f(x)= 1/1+e^{-x}$ is an appropriate transform function for restricting the values of $A_i^{(k)}$ in the interval [0,1].

Step 7: *Calculate factors' values:* Each risk indicator's value is computed via Formulation (1), by taking the weighted arcs into consideration.

Step 8: *Provide scenario analyses:* Scenario analyses are incorporated to understand the effect of an increase or a decrease of the importance of specific concept(s) on other concepts.

Steps 6-7 are repeated until the concepts reach equilibrium which means that the system has to be stabilized after required iterations.

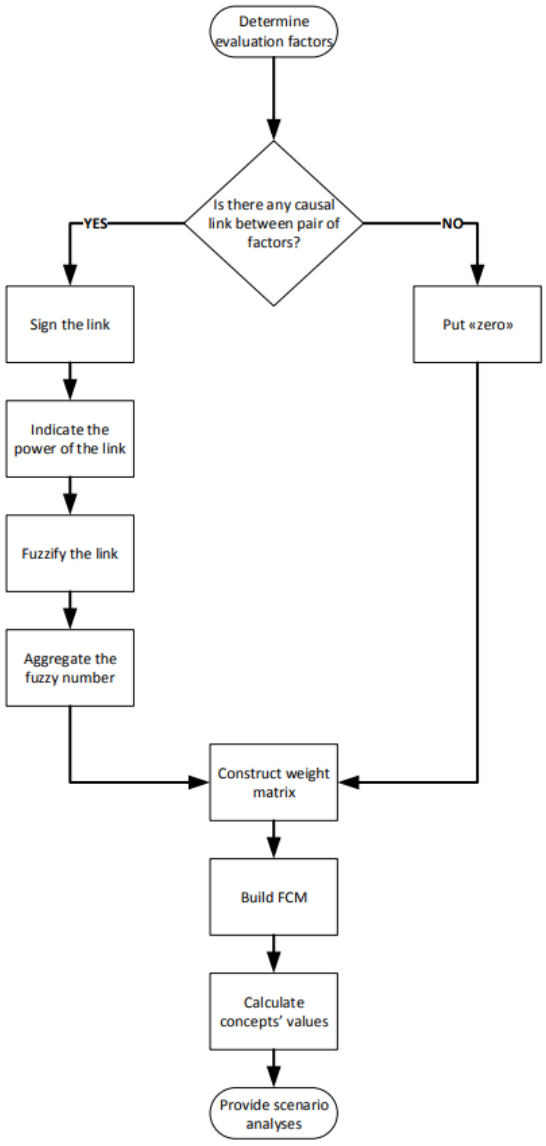

Fig 1 The stepwise representation of the proposed methodology

Table 1 Scale of Fuzzy Numbers

Linguistic Term	Fuzzy Number
nvs	(-1,-1,-0.75)
ns	(-1,-0.75,-0.5)
nm	(-0.75,-0.5,-0.25)
nw	(-0.5,-0.25,0)
z	(-0.25,0,0.25)
pw	(0,0.25,0.5)
pm	(0.25,0.5,0.75)
ps	(0.5,0.75,1)
pvs	(0.75,1,1)

III. NUMERICAL ILLUSTRATION

This section illustrates the application of the proposed FCM approach for evaluating risk factors of BPO. The case study is conducted in a bank that performs in Turkish banking sector. Initially, there decision makers indicated whether there is a relationship between each pair of factors. Then, they determined the direction and the power of relationships by using nine linguistic terms mentioned in the previous section. The decision matrix formed by three experts is given in Table 2.

Table 2 Decision matrix formed by three experts

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	(z,z,z)	(nm,z,nm)	(nw,nw,ns)	(ns,nvs,ns)	(z,z,z)	(z,z,z)	(nw,ns,nw)
C_2	(z,z,z)	(z,z,z)	(pvs,pm,pvs)	(pw,pw,pw)	(z,z,z)	(z,z,z)	(z,z,z)
C_3	(nw,ns,nm)	(ps,ps,pvs)	(z,z,z)	(pw,pw,z)	(z,z,z)	(z,z,z)	(z,z,z)
C_4	(z,z,z)	(z,z,z)	(z,z,z)	(z,z,z)	(z,z,z)	(z,z,z)	(z,z,z)
C_5	(z,z,z)	(z,z,z)	(z,z,z)	(z,z,z)	(z,z,z)	(nm,z,nm)	(nm,nw,nm)
C_6	(z,z,z)	(pw,pm,pm)	(z,pw,z)	(z,ps,pm)	(nm,nm,nm)	(z,z,z)	(z,z,z)
C_7	(z,z,z)	(pm,pw,pm)	(z,z,z)	(pm,pw,pm)	(z,z,z)	(pw,z,pw)	(z,z,z)

Afterwards, these linguistic variables are transformed into triangular fuzzy numbers, they are aggregated with MAX method, then they are defuzzified by centre of gravity method. Finally, the weight matrix that shows the aggregated causal links between each pair of factors, is obtained as Table 3. FCM with directions is represented in Figure 2.

Table 3 Weight Matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	0	-0.25	-0.5	-0.798	0	0	-0.5
C_2	0	0	0.648	0.25	0	0	0
C_3	-0.5	0.798	0	0.125	0	0	0
C_4	0	0	0	0	0	0	0
C_5	0	0	0	0	0	-0.25	-0.375
C_6	0	0.375	0.125	0.397	-0.5	0	0
C_7	0	0.375	0	0.375	0	0.125	0

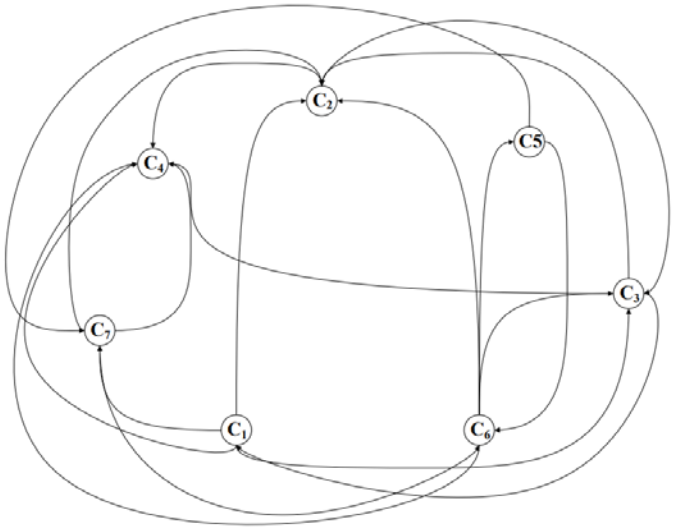

Fig 2 FCM with directions

In FCM, indices are computed to view the types of causal effects of each factors for the main problem. Outdegree values refer to the total effect of the factor under observation, indegree values represent how the factor under evaluation is influenced by other criteria, and centrality values state the sum of outdegree and indegree values. Indices are listed in Table 4.

Table 4 Indices

Concept	Outdegree	Indegree	Centrality
C_1	2.05	0.50	2.55
C_2	0.90	1.80	2.70
C_3	1.42	1.27	2.70
C_4	0.00	1.95	1.95
C_5	0.63	0.50	1.13
C_6	1.40	0.38	1.77
C_7	0.88	0.88	1.75

By applying formulation (1), the iterative FCM process is run and the concept value for each factor is obtained by using FCMapper software. The results are given in Table 5.

Table 5 Values of BPO Risk Factors

Concept	Concept's Value
C_1	0.541081
C_2	0.851368
C_3	0.752775
C_4	0.742786
C_5	0.560214
C_6	0.636364
C_7	0.506459

A. Scenario Analyses

Scenario 1: For the outsourcer firm, employee productivity of the outsourcing provider company may be a more important risk factor in the increasing competition of the market. If the importance degree of employee productivity of the service provider increases to 0.9 from 0.506459, the importance of agility increases since more productive personnel can easily work in a more agile way. On the other hand, the provider firm becomes more reliable, and its access to information is developed thanks to improved employee productivity. Besides, technological complexity of the outsourced task becomes less important. The resulting concept values of Scenario 1 are given in Table 6.

Table 6. Results of Scenario 1

Concept	No Change	Scenario 1
C_1	0.541081	0.5404875
C_2	0.851368	0.8724253
C_3	0.752775	0.7563645
C_4	0.742786	0.7782739
C_5	0.560214	0.5577907
C_6	0.636364	0.6511807
C_7	0.506459	0.9

Scenario 2: Agility is a notion that becomes more popular in the recent years. Thus, there may be some outsourcer companies that do not have a high opinion of this concept. For such firms, the importance of agility is less than the companies that are aware of agility. Hence, in this scenario, we decrease the importance of agility to 0.3 from 0.851368, and observe the changes on the importance degrees of the other factors. First, weak management becomes more risky on BPO since being agile increases management capability. Second, coordination decreases when the service provider is not agile. In addition, one can conclude that less agility less reliability as shown in Table 7.

Table 7 Results of Scenario 2

Concept	No Change	Scenario 1
C_1	0.541081	0.5567128
C_2	0.851368	0.3
C_3	0.752775	0.6577626
C_4	0.742786	0.7019115
C_5	0.560214	0.5602307
C_6	0.636364	0.6362648
C_7	0.506459	0.5038523

Scenario 3: In the developing technology, an outsourced task may be very complicated. In such a situation, the importance of technological complexity as a risk factor increases. We suppose that it increases to 0.9 from 0.560214. Hence, the powers of information accessibility and employee productivity decrease decently, whereas the importance of agility decreases rather few. Thus, information accessibility and employee productivity become more risky when the outsourced task is technological complicated. Resulting values of Scenario 3 is provided in Table 8.

Table 8 Results of Scenario 3

Concept	No Change	Scenario 1
C_1	0.541081	0.541315
C_2	0.851368	0.8473341
C_3	0.752775	0.7513549
C_4	0.742786	0.7360361
C_5	0.560214	0.9
C_6	0.636364	0.608654
C_7	0.506459	0.4640305

IV. CONCLUDING REMARKS

Globalization, competitive market and increasing technologic developments lead companies to deal with every kind of change for sustaining their competitive advantages. Firms must take into account risk measures for surviving in the market. Outsourcing is a strategic component, which is to disintegrate peripheral business process activities. It has many advantages, as well as potential disadvantages and risks, hence risk evaluation of outsourced processes is required for clients to cope with market competition, for providers to understand their performance measures in order to assess themselves.

This work proposes a FCM approach for evaluating risk factors in BPO. Since there are cause-and-effect relationships between criteria, and the problem can be represented by a network, FCM method is thought to be appropriate to assess the risk factors of BPO. Applying the iterative formulation (1) of FCM, the system is become stabilized and the concept value of each BPO risk factor is obtained. According to the FCM results, agility is the most important risk criteria, followed by coordination and reliability. On the other hand, weak management, technological complexity, and employee productivity are thought to be less important criteria of BPO relationship. In addition, three scenario analyses are provided

employed to understand the influence of an increase or a decrease of the power of specific concept(s) on other concepts.

Future research directions may focus on selecting the suitable outsourcing providers by considering the importance degrees of risk criteria.

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Nazlı Goker is a research assistant of Industrial Engineering at Galatasaray University, Turkey. She holds BS and MS degrees in Industrial Engineering from Galatasaray University. Her areas of interest include DEA based models and multi-criteria decision making with special focus on performance management. She has co-authored articles that appeared in Applied Soft Computing.

Mehtap Dursun is an assistant professor of Industrial Engineering at Galatasaray University, Turkey. She holds BS, MS, and PhD degrees in Industrial Engineering from Galatasaray University. Her areas of interest include quality function deployment, fuzzy optimization, and multi-criteria decision making with special focus on waste management, personnel selection, and supplier selection. She has co-authored articles that appeared in Expert Systems with Applications, Resources Conservation and Recycling, International Journal of Production Research, and Applied Mathematical Modelling.