An FCM Approach for Agility-Based Risk Assessment in Business Process Outsourcing

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Abstract: Business process outsourcing is an improved version of information technologies outsourcing, which is considered to be a new big current in information systems services. This work proposes a fuzzy cognitive map methodology (FCM) for evaluating risk criteria in business process outsourcing. FCM, which represents experts' knowledge and human experience, is to assess risk factors of business process outsourcing by introducing concepts to define criteria and causality links among the concepts for modelling a system's behaviour. Since there are causal links between criteria, and the problem can be represented by a network, FCM method is thought to be suitable to evaluate the risk factors of business process outsourcing. The case study is conducted in a bank that performs in Turkish banking sector. Agility is the most important risk criteria of business process outsourcing, followed by coordination and reliability according to FCM results.

Key-Words: - Business process outsourcing, agility, risk factors, fuzzy cognitive map, causal links, fuzzy decision support

1 Introduction

Nowadays, companies concentrate on their core business processes. They focus on t heir 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 l ong 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. H owever, 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].

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 [2].

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, psychological risk is related to responsible manager's reputation and career when the business process is damaged because of the outsourcing [3].

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.

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

2 Fuzzy Cognitive Map 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 [4]. Hereafter, Taber and Kosko [4-6] 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 [6]. 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 [7]. $C = \{C_1, C_2, ..., C_n\}$ 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 application steps of the FCM method are summarized as follows:

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.

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

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)

3 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. 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.

	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)

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

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 4.

Table 4. 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

4 Conclusion

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.

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

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