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# A Cognitive Mapping Approach for Evaluation of Success Indicators of IT Transformation Project

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***Abstract*—** In this digital age, companies aim to integrate agility concept not only in their manufacturing-related or project-specific processes, but also in whole organization, in other words the objective is to make agile organizations. For that reason, organizational transformation is essential since making organizations agile necessitates fundamental change. Organizational transformation, which is a strategic methodology, aims to enable to change the whole organizational structure of companies using digital and technology. In increasing technology and digital environment, organizational transformation usually means to integrate agility concept into the entire organization, in other words, create agile organizations. The aim of this work is to identify the importance degrees of success factors of information technology (IT) transformation project of company performing in Turkish durable consumer goods industry. For that purpose, intuitionistic fuzzy cognitive map (IFCM) is considered as suitable tool due to the existence of causal links among the factors, lack of crisp data and the presence of hesitation in data**.**

***Keywords*—** Organizational transformation, IT transformation, causal links, cognitive maps, intuitionistic fuzzy data

## I. INTRODUCTION

Organizational transformation is a strategic methodology of getting organization from here to future. It begins when the firms recognize that change is necessary.

There are many factors that lead companies to organizational transformation. The first one could be performance-related factors. The second indicator could be culture-related, in other words there may be leadership-related indicators like a lack of employee training or poor communication [1].

In this work, we focus on whole information technology (IT) transformation. Integration of a large-scale IT transformation project influences the whole organization. In a technology-oriented transformation project, an organization focuses on acquiring and installing the right hardware and software. However, the people who are going to use the new technologies and the processes evaluate them whether they are user friendly or not. As critical as the new technologies may be, they are only tools for people to use in carrying out the agency's work [2]. Since the success of a transformation process is critical, it should be evaluated by taking into account success indicators in order to avoid any failure.

This study presents an intuitionistic fuzzy cognitive map (IFCM) approach to identify the importance degrees of success factors of IT transformation project. IFCM is thought as an appropriate tool due to the causal links among the factors, lack of crisp data and the presence of hesitation in data.

The rest of the work is organized as follows. Section 2 explains material and methods. The following section illustrates the application via a case study conducted in banking sector. Final section delineates conclusions and future research directions.

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## II. MATERIALS AND METHODS

### A. Cognitive Maps

Cognitive maps (CMs) were originally proposed by Axelrod [3] as a tool to model decision support systems in political and social sciences. CMs comprise directed edges which provide modeling causalities and interrelationships among concepts. There are multiple types of CMs, such as signed, weighted and functional graphs.

A crisp CM, which is indeterminate, can be solved by providing a numerical weighting, however, it requires computational and conceptual efforts [4].

FCM, helping model complex decision systems, is a causal knowledge-based method which is originated from the combination of fuzzy logic and neural networks [4]. The 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. Concept nodes and weighted edges are the elements of FCM which can be graphically showed with feedback. Edges are signed to understand the direction of causality: whether the causal relationship is positive, negative or null, and connect the nodes

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through which causal relationships among concepts are produced [5].

In recent years, intuitionistic extensions are pro-vided to deal with the limitations of FCM by using IFSs [6]. Initially, Iakovidis and Papageorgiou [7] introduced IFCM for the problem occurred in medi-cal decision making. Afterwards, Hadjistoykov and Atanassov [8] and Papageorgiou and Iakovidis [9] improved the method and proposed IFCM-II. More recently, Hadjistoykov and Atanassov [10] devel-oped temporal IFCM that aims to extend the tech-nique using temporal parameters.

IFCM tool that utilizes intuitionistic fuzzy num-bers to express the power of cause-and-effect rela-tionships in cognitive mapping [6]. Initially, concept nodes and power of causal links among them are defined by collecting experts' opinions. Hereafter, intuitionistic fuzzy scale is determined and the power of causal links is represented by intuitionistic fuzzy numbers that are associated with the scale. Hence, membership, non-membership, and hesitation values are identified. By using the information obtained from the experts, ***N*** x *N* weight matrix is constructed. In order to compute the concepts' values, the following iterative formulation is run until the system will be stabilized, in other words, all factor weights will converge Iakovidis and Papageorgiou [7].

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

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 $C_i$, $w_{ji}^{\mu}$ and $w_{ji}^{\pi}$ denote the weight matrices that show membership values and hesitation values of causal links, respectively, and $f$ is a threshold function, which is considered as sigmoid function for this work.

## III. CASE STUDY

The illustration of the proposed methodology is represented by a case study conducted in a manufacturer that performs in Turkish durable consumer goods sector. First, the factors that have influences on the success of IT transformation project as given in Table 1, are identified by interviewing the managers of the case company.

Table 1. IT transformation factors

| Label | Concept |
|---|---|
| $C_1$ | Communication and team working |
| $C_2$ | Job design capability |
| $C_3$ | Analytical planning |
| $C_4$ | Effective execution |
| $C_5$ | Competency management |
| $C_6$ | Performance measures |
| $C_7$ | Leadership |

The evaluation is conducted by a committee of three decision-makers that are all IT managers who have all been working for more than three years in the case company. The experts provide their opinions by reaching a consensus and they used the linguistic scale shown in Table 2.

Table 2. Linguistic scale

| Linguistic term | Intuitionistic fuzzy number |
|---|---|
| VH | <0.95,0.05> |
| H | <0.70,0.25> |
| M | <0.50,0.40> |
| L | <0.25,0.70> |
| VL | <0.05,0.95> |

The evaluations are given in Tables 3, 4, 5, and 6.

Table 3. Linguistic data for causal links

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ | $C_7$ |
|---|---|---|---|---|---|---|---|
| $C_1$ | - | L | M | H | - | - | L |
| $C_2$ | - | - | - | M | - | - | - |
| $C_3$ | L | VL | - | H | - | - | - |
| $C_4$ | - | M | - | - | - | - | - |
| $C_5$ | - | - | - | - | - | VH | - |
| $C_6$ | - | - | - | - | H | - | - |
| $C_7$ | M | - | M | H | - | - | - |

Table 4. Membership values for causal links

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ | $C_7$ |
|---|---|---|---|---|---|---|---|
| $C_1$ | 0 | 0.25 | 0.5 | 0.7 | 0 | 0 | 0.25 |
| $C_2$ | 0 | 0 | 0 | 0.5 | 0 | 0 | 0 |
| $C_3$ | 0.25 | 0.05 | 0 | 0.7 | 0 | 0 | 0 |
| $C_4$ | 0 | 0.5 | 0 | 0 | 0 | 0 | 0 |
| $C_5$ | 0 | 0 | 0 | 0 | 0 | 0.95 | 0 |
| $C_6$ | 0 | 0 | 0 | 0 | 0.7 | 0 | 0 |
| $C_7$ | 0.5 | 0 | 0.5 | 0.7 | 0 | 0 | 0 |

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Table 5. Non-membership values for causal links

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ | $C_7$ |
|---|---|---|---|---|---|---|---|
| $C_1$ | 0 | 0.7 | 0.4 | 0.25 | 0 | 0 | 0.7 |
| $C_2$ | 0 | 0 | 0 | 0.4 | 0 | 0 | 0 |
| $C_3$ | 0.75 | 0.95 | 0 | 0.25 | 0 | 0 | 0 |
| $C_4$ | 0 | 0.4 | 0 | 0 | 0 | 0 | 0 |
| $C_5$ | 0 | 0 | 0 | 0 | 0 | 0.05 | 0 |
| $C_6$ | 0 | 0 | 0 | 0 | 0.25 | 0 | 0 |
| $C_7$ | 0.4 | 0 | 0.4 | 0.25 | 0 | 0 | 0 |

Table 6. Hesitation values for causal links

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ | $C_7$ |
|---|---|---|---|---|---|---|---|
| $C_1$ | 0 | 0 | 0.1 | 0.05 | 0 | 0 | 0 |
| $C_2$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $C_3$ | 0 | 0 | 0 | 0.05 | 0 | 0 | 0 |
| $C_4$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $C_5$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $C_6$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $C_7$ | 0.1 | 0 | 0.1 | 0 | 0 | 0 | 0 |

IFCM methodology is employed and the weights of success indicators are obtained by running the formulation (1) until it will be stabilized, and the values of concepts will no longer change. FCMapper software is utilized for these operations. The criteria weights are provided in Table 7.

Table 7. Weights of success indicators

| Label | Concept | Weight |
|---|---|---|
| $C_1$ | Communication and team working | 0.7800 |
| $C_2$ | Job design capability | 0.8221 |
| $C_3$ | Analytical planning | 0.8020 |
| $C_4$ | Effective execution | 0.9471 |
| $C_5$ | Competency management | 0.7991 |
| $C_6$ | Performance measures | 0.8306 |
| $C_7$ | Leadership | 0.7125 |

## IV. CONCLUSIONS

In this digital era, companies are transforming into more agile and adaptive organizations. When the enterprises aim to reach the organizational from here to the future, thus transformation becomes a strategic tool. In order to gain advantage in competitive environment, transformation projects should be successful, hence performance evaluation of these projects are significant. The objective of this study is to identify the importance degrees of success indicators of an IT transformation project that is conducted in a manufacturer firm, which performs in Turkish durable consumer goods industry.

To obtain the importance weights success indicators, related factors affecting the performance of IT transformation project are listed through expert opinions. The resulting concepts' values are obtained by applying IFCM methodology, effective execution is the most influential factor on IT transformation project success, however leadership is the least effective one on success.

Future research directions will focus on comparing the importance degrees of the success indicators with another mapping tool, which allows to aggregate different experts' opinions. For that reason, a group decision approach will be proposed rather than making a consensus among decision makers.

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