COGNITIVE MODELING FOR ORGANIZATIONAL LEARNING

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ABSTRACT

There is a growing tendency to consider organizational learning as a trait of successful organizations. In this research, we divide an organizational learning process into two dimensions: knowledge transfer and behavioral change. Knowledge transfer emphasizes the understanding of an existing organizational context, while behavioral change focuses on the organizational behavior reengineering that may lead to significant organizational restructuring. Based on these dimensions, we present a two-phase cognitive modeling methodology designed to support organizational learning from the organizational behavior perspective.

INTRODUCTION

As organizations struggle to reshape themselves to cope with the rapidly changing external environment, interests on organizational learning have been growing. Organizational learning is being considered as a core mechanism for improving organizations and the rate at which organizations learn is perceived as a source of their competitive advantage [4][7][8]. Although several recent surveys identified organizational learning as a critical IS issue [2][3], there have been little research on the systematic modeling methodology for supporting organizational learning.

CONCEPTUAL FRAMEWORK

In this section, we will discuss the three elements relevant to our study: 1) organizational learning, 2) cognitive modeling, and 3) cognitive map.

Organizational Learning

While organizational learning has been studied and defined for a long time by numerous researchers, most of them relate organizational learning with knowledge transfer or behavioral change. However, either knowledge transfer or behavioral change cannot by itself trigger organizational learning. Without knowledge transfer, organizations simply repeat old behaviors. In the absence of behavioral change, newly transferred knowledge becomes futile. As a consequnece, it is essential to consider both aspects for complete organizational learning. Garvin's definition for organizational learning [6] seems most appropriate in this context. In this research, we extend Garvin's definition by explicitly dividing it into two dimensions: knowledge transfer and behavioral change. *Knowledge transfer* involves the creation of knowledge, the acquisition of knowledge, and the transfer of knowledge among organizational members that enables them to enhance organization's efficiency, and emphasizes the understanding of an existing organizational context. Through the knowledge transfer, organizational members can extend their thinking scope to the overall organization beyond their own boundary. In turn, this change facilitates cooperative work among members, which leads to a more efficient organization. *Behavioral change* involves the modification of behaviors among organizational members that enables them to enhance organization's effectiveness, and emphasizes the organizational behavior reengineering that requires significant organizational restructuring. Based on the transferred knowledge and changed ways of thinking, an organization can create a new type of knowledge on how to change its behavior.

Cognitive Modeling

We construct models to highlight or emphasize certain critical features of a system, while simultaneously de-emphasizing other less important aspects of the system [10]. Process modeling emphasizes process and data modeling focuses on data, whereas cognitive modeling deals with interrelationships among cognitive concepts. An organization can be perceived as a complex network consisting of interrelated causal elements. By modeling the cognitive aspects of an organization, we can easily capture the major interrelationships and patterns within the organization and can improve the systems thinking capability.

Cognitive Map

Tolman [9] introduced the term cognitive map to the psychology literature in the 1940s. Axelrod [1] used cognitive map in the 1970s for representing social scientific knowledge. A cognitive-map is a representation of relationships that are perceived to exist among the attributes and/or concepts of a given environment [11]. Various researchers have named it differently depending on their contexts: cognitive map, cause map, and influence diagram. The constructs of a cognitive map are node, called causal concept, link, representing causal connection among causal concepts, and value, specifying causal strength of causal connection.

TCM METHODOLOGY

In this research, the modeling for organizational learning consists of the following two phases: 1) knowledge transfer and 2) behavioral change.

Phase 1: Knowledge Transfer

In this phase, we capture each individual agent's perception and understanding of the organization in a cognitive map which consists of causal concepts, causal connections, and weighted causal values. Through this phase, we can gain an overall understanding of organizational behavior and, based on this understanding, we can improve organization's efficiency. The result of this phase is to be used in phase 2 to aim at behavioral changes.

Step 1: Identify individual agents

In this research, an agent is defined as an organizational unit which transfers and shares its knowledge with other units through communication. It is important to capture the critical business areas. If an area has a problem, we will identify its cause and solution. If an area has an opportunity, we will find the means to materialize the opportunity. Clarifying the goal of each agent helps the analysts capture the cause-effect relationships among cognitive elements. Because individual agents behave to fulfill their goal, we can view the cognitive map as describing procedures for accomplishing their goal through the cause-effect relationships.

Step 2: Generate local cognitive map

This step generates local cognitive maps for the previously identified agents. Our cognitive map allows diverse concepts such as state-based (ex., sales), action-based (ex., marketing activity), or emotion-based (ex., employee satisfaction) concepts. Several techniques exist to help specify the causal values of each relationship. The subjective weights of analysts can be used, and the result of the statistical analysis can be assigned to the relationships.

Step 3: Generate global cognitive map

This step generates a global cognitive map by combining each local cognitive map, which leads to the common view for the problems or opportunities. The global cognitive map plays a role as the organizational memory. In order to combine the local cognitive maps, we first identify the common causal concepts between any two local cognitive maps, and link the maps using these concepts. In turn, the next local cognitive map is joined with the previous result. This way, the combination process continues until all local cognitive maps are exhausted. While the local cognitive maps are being combined into a global cognitive map, various conflicts among the local cognitive maps might appear. These conflicts should be detected and resolved in order to create a complete global cognitive map. Conflicts may occur in each construct of a cognitive map: causal concept conflict, causal connection conflict, and causal value conflict. During the combination process, new concepts or new connections can be introduced into the global cognitive map, if necessary for describing the overall organizational behavior, along with appropriate causal values assigned. It is necessary to specify the goal of the group agent. Clarifying the goal of the group agent is helpful to understand the overall organizational behavior that depends on the various cause-effect relationships.

Phase 2: Behavioral Change

In phase 2, we extract the causal impact paths and values based on the global cognitive map. This phase is addressed computationally by an algorithm. In this phase, we identify the opportunities for organizational behavior reengineering.

Step 1: Generate global cognitive matrix

In this step, we prepare for proceeding toward phase 2 which triggers behavioral change. The global cognitive map can be transformed into an equivalent matrix form called global cognitive matrix. It represents the direct causal impact between the causal concepts including the causal strength values of the relationships. Rows and columns of a global cognitive matrix consist of all causal concepts in the global cognitive map, and each row and column corresponds to a specific causal concept. Each cell entry of a global cognitive matrix corresponds to a relationship between any two causal connections, and the value of the cell entry indicates the causal strength of the corresponding relationship. Causal concept i's impact on causal concept j is represented in cell (i, j). In this way, we construct an $n \times n$ matrix with u_{ij} as a vale of cell (i, j) ,where n is the number of the causal concepts and u_{ij} is the causal strength value from i to j which lies in the interval [-1, 1].

Step 2: Compute causal impact paths and values

In this step, we compute causal impact paths and values based on the result of the previous step. The previous step deals with the direct causal impact paths and values which are given directly from the global cognitive map, whereas the current step reveals the causal impact paths with the maximum causal impact values regardless of the direct impact or the indirect impact. These causal impact paths may take the negative values or the positive values or both, depending on the causal impact values consisting of the feedback loops. In order to compute the causal impact paths and values, we adopted the algorithms proposed by Zhang et al. [11], and partially modified them to compute the paths and values simultaneously. At the end of step 2, we get an $n \times n$ global cognitive matrix consisting of X_{ij}, where X_{ij} is a set of $\{+p_{ij}, -p_{ij}, +v_{ij}, -v_{ij}\}$. Each element of the set is as follows: $+p_{ij}$-p_{ij} is a maximum positive/negative causal impact path, $+v_{ij}$-v_{ij} is a maximum positive/negative causal impact value from causal concept i to causal concept j.

Step 3: Analyze causal impact paths and values

The objective of this step is to identify opportunities for organizational behavior reengineering. Through this step, we might change the existing ways of how to perceive ourselves and to respond to the organizational context. These opportunities can be identified from the agency problem, risk taking, and process redesign perspectives.

***(1) Agency problem perspective*:** Based on the causal impact paths, we can address the agency problem. Most of the organizations consist of various agents which have their own goals. Agency theory is concerned with resolving the agency problem that may occur in the agency relationship. Agency problem occurs when two parties have different goals and it is difficult or expensive for the principal to verify what the agent is actually doing [5]. Different actions within the organization due to the goal conflicts between multiple agents may lead to overall organizational ineffectiveness. Accordingly, agency problem should be considered as a factor for organizational effectiveness and it is necessary to understand and resolve the problem in order to enhance the learning capability of the organization. Because each agent makes efforts to accomplish its own goal, the goal conflicts between agents and between the agent and principal may occur. If these conflicts are not detected and resolved appropriately, it may result in performance degradation for the overall organization although local performance may be good. As a result, it is necessary to coordinate or control the behavior of agents based on the identified conflicts.

(2) Risk taking perspective: From the result of the causal impact paths and values, we can identify an opportunity to modify the agents' behaviors depending on their perceptions for the risk. The causal impact paths may take both positive and negative impact value rather than take only positive or only negative impact value because of the effect of the feedback loops. Therefore, we can analyze both positive and negative side of agents' behavior for accomplishing their goal. Because of the duality of the causal impact path, agents can modify their behavior according to the degree of risk taking. For the two alternatives to accomplish the same goal, a risk averter tends to select an alternative with less negative impact, while a risk taker is inclined to take an alternative with more positive impact.

(3) Process redesign perspective: We can also find another opportunity to modify the agents' behaviors, which leads to the redesign of the existing organizational process. In order to search for the chances of the process redesign, we first focus on the most effective causal concept in achieving the goal regardless of the sign of the impact. It can be an opportunity when it is a positive impact, but it can be a problem when it is a negative impact. After this, we can modify behaviors based on the relevant connections or feedback loops so as to make the positive impact stronger and the negative impact weaker. Modification of the organizational behavior can be performed in two ways. First, the modification can be conducted through the generation of new feedback loops. These also may be generated by adding new causal concepts or by inserting new causal connections into the existing global cognitive map. Second, elimination of the undesirable feedback loops from the existing global cognitive map can lead us to modification. This includes elimination of the undesirable causal connections and elimination of the unnecessary causal concepts. These modifications may lead to the redesign of the existing organizational process. Generation of the new feedback loops means that a new business process is applied to the organizational context. Elimination of the undesirable feedback loops means that the existing process is changed in the organizational context.

CONCLUSION AND FUTURE DIRECTIONS

We presented a two-phase cognitive modeling (TCM) methodology designed to support organizational learning from the organizational behavior perspective. Through TCM, we looked into opportunities that can be identified from the agency problem, risk taking, and process redesign perspective. One of the future directions of this research is to include how to elicit causal values in generating cognitive map. Another direction is to extend our modeling methodology into the areas of integrated process and data modeling since the cognitive model can play a role as a complement for the other two modeling techniques.

References

[1] Axelrod,R., *Structure of Decision: The Cognitive Maps of Political Elites*, Princeton, NJ: Princeton University Press, 1976

[2] Brancheau, J.C., Janz, B.D., and Wetherbe, J.C., "Key Issues in Information Systems Management: 1994-95 SIM Delphi Results," *MIS Quarterly*, June, 1996, pp. 225-246

[3] Brancheau, J.C., and Wetherbe, J.C., "Key Issues in Information Systems Management," *MIS Quarterly*, March, 1987, pp. 23-46

[4] Edmondson, A., and Moingeon, B., "Organizational Learning as a Source of Competitive Advantage: When to Learn How and When to Learn Why," *Proceedings of the First Asia Pacific DSI Conference*, 1996, pp. 691-699

[5] Eisenhardt, Kathleen M., "Agency Theory: An Assessment and Review," *Academy of Management Review*, Vol. 14, No. 1, 1989, pp. 57-74

[6] Garvin, D.A., "Building a Learning Organization," *Harvard Business Review*, July-August, 1993, pp. 78-91

[7] Senge, P.M., *The Fifth Discipline: The art and practice of the learning organization*, New York: Doubleday, 1990

[8] Stata, R., "Organizational Learning: the Key to Management Innovation," *Sloan Management Review*, Vol. 12, No. 1, Spring, 1989, pp. 63-74

[9] Tolman, E.C., "Cognitive Maps in Rats and Men," *Psychological Review*, Vol. 55, 1948, pp. 189-208

[10] Yourdon, E., *Modern structured analysis*, Englewood Cliffs, NJ: Yourdon, 1989

[11] Zhang, W.R., Chen, S.S, and Bezdek, J.C., "Pool2: A Generic System for Cognitive Map Development and Decision Analysis," *IEEE Transactions on Systems, Man, and Cybernetics*, Vol. 19, No. 1, 1989, pp. 31-39