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Addressing Behavior in Collaborative Networks

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Abstract. Many factors such as weak partner commitment, lack of proper partners' alignment on interest and values, individualism, lack of flexibility, and loss of autonomy may cause partnership's failures in collaborative networks. Most of these serious causes for conflicts in collaborative networks are rooted in partner's behavior, therefore analyzing and modeling the behavioral aspects of collaborative networks are important to enforce their success. This paper first addresses two kinds of behavior related to collaborative networks including *Individual Collaborative Behavior* and *Network Collective Behavior*, and then introduces an approach to measure the comparative individual collaborative behavior of partners in networks.

Keywords: Collaborative Networks, Individual Collaborative Behavior, Collective Behavior, Causal Reasoning

1 Introduction

With advances in communication and information technology, today organizations can interact and communicate with each other and exchange sensitive information without the traditional limitations of time and location. Collaborative networks, such as global supply chains, support industries to manufacture and deliver products to markets with the required speed and efficiency. A CN (collaborative Network) is an alliance constituting a variety of entities (e.g. organizations and people) that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital, and goals, and that cooperate and collaborate to better achieve common or compatible goals, and whose interactions are supported by the computer network [1],[2].

In general, each organization (or person) involved in a collaborative partnership works and interacts with other members to achieve common or compatible goals. During this interaction partners expose various behaviors, according to the situations

in which they are involved. This kind of behavior is called *Individual Collaborative Behavior*, regarding to how one behaves within a CN. If it were possible to analyze, model and predict the organizations' behaviors, many conflicts and difficulties in CNs could have been resolved and ultimate productivity of individuals at the CNs would have been drastically improved [3]. Another kind of behavior related to CNs is the *Network Collective Behavior* which shows the behavior of a group of partners, as a whole. Effective Network Collective Behavior leads to improved CN productivity and higher quality, thus more customer satisfaction, as well as more profit and more power for the CNs.

Inspired by the modeling frameworks introduced earlier in the literature related to collaborations and network aspects [4] and considering the complexity of CNs, the ARCON (A Reference model for Collaborative Networks) modeling framework is developed. This framework divides the CNs complexity into a number of perspectives. Its environment characteristics perspective includes two subspaces that cover the internal elements characteristics of CNs, labeled as "Endogenous Elements (Endo-E)", as well as the external interactions characteristics, labeled as "Exogenous Interaction (Exo-I)", that address the logical surrounding of the CNs. The Endo-E subspace consists of four perspectives, as follows: Structural dimension, Componential dimension, Functional dimension and Behavioral dimension [5],[6]. Among these four, the behavioral dimension is the least studied in the research on CNs. However, there are some base applicable research related to human behavior and agent behavior. In [7], the authors show the feasibility of soft control on collaborative behavior of a group by a case study. In [8], a new attempt for modeling and simulation of group behavior in e-government organizations is provided and also [9] presents a qualitative simulation method for analyzing employee group behavior by integrating QSIM (Qualitative SIMulation) with basic causal reasoning. Moreover, some issues such as the small world phenomenon, clustering and power relationships from the area of Social Networks Analysis (SNA) may contribute to this topic. For example, in [10], some indicators related to promote the fairness and transparency are proposed. Some Other indicators, such as reliability, responsiveness, flexibility, etc. are defined in the SCORE model [11] known throughout industrial branches. Standardizing processes within a supply chain because of making the process comparable and compatible is the goal of this model and these indicators are used to measure the performance of organization in supply chains.

This paper is organized as follows: in section 2, the individual collaborative behavior and a new approach to measure the comparative individual collaborative behavior are addressed. In section 3 the Network Collective Behavior is discussed, and finally in section 4 some conclusive remarks are drawn.

2 Individual Collaborative Behavior

The principles, policies, and governance rules that either drive or constrain the behavior of the CN and its member over time, are addressed in behavioral dimension of the ARCON reference model [5]. This may include elements such as honesty and

integrity, trust, openness, well performance, professionalism, mutual respect, commitment to network, code of ethics and IPR policy. Considering these governance rules and some other related factors, it is possible to introduce an approach for measurement of comparative individual behavior. Below, we first discuss the importance of the individual collaborative behavior (in section 2.1) and then we explain our approach to model it (in section 2.2).

2.1 The Role of Individual Collaborative Behavior in CNs

Due to the impressive number of both human and organizational behavioral factors found in the analyzed reports, an assumption can be made that probably most partnership failures and successes are strongly related to, if not caused by, the behavioral factors of the involved partners [3]. Good communication, decision by consensus, creativity, fairness, flexibility, best use of interests, knowledge sharing, joy in working together, visible leadership, readiness, open and honest participation, willingness to commit resources and capabilities, development of social skills, transparency in provision of information are behavioral factors leading partnership's success.

Moreover, partners' behavioral factors have a vital influence on their collaboration readiness and establishing trust relationship with other partners, while individual collaborative behavior can be motivated through creation of incentives and rewarding models and mechanisms as a part of CN's governance model.

Analyzing the behavior of a CN's members is therefore necessary. Obviously, the purpose of modeling and analyzing the individual behavior may target specific objectives. These objectives may include identification or prediction of conflicts, selecting the best-fit members to create a new VO, better role and right assignment in CNs, effective membership structure management, and general measuring of individual collaborative behavior in networks.

2.2 Measuring the Comparative Individual Behavior

Modeling and analyzing behavior of CN partners involve different sets of characteristics, and depends on the perspective for which the behavior is considered. Therefore, it is better to consider some perspectives for each of above mentioned objectives.

As such, behavior for a CN partner cannot be represented by an absolute value; rather it can be measured for instance regarding a specific purpose against the behavior of other CN partners. Mechanisms can be defined to assess the individual behavior of a CN partner in comparison to others. For this purpose, every perspective can be characterized by a set of traits / actions. Also, specific metrics (variables that can be measured) and constraints shall be specified for each trait/action.

Table 1: Perspectives, traits and metrics *for partner selection objective*

Perspectives	Traits/Actions	Metrics	
Conforming to past VO Regulations (CR)	Punctuality	e.g. average hours/days of delay in product delivery	
	Pro-activity	e.g. number of articles published in the press, number of new recommended members, and number of awards won	
	Flexibility	e.g. average period of time (in hours or days) to develop or change a new logistic process and percentage of time without process faults	
	Responsiveness	e.g. average response time to emails (in hours or days)	
	Responsibility	e.g. number of successful collaboration involved, number of responsibilities or roles accepted in past experiences	
	Innovation	e.g. average number of industrial patents per year in last five years	
	Keeping commitment	Problem/conflict resolution	e.g. number of problems that escalated to VO management
		Willingness to adapt	e.g. percentage of accepted adaptations to new required plans
		Willingness to compensate	e.g. difference between delay in input and delay in output
		providing impulses	e.g. number of suggestions realized for improvements
Problem avoidance		e.g. provided reaction time (in hours or days) when critical status is reported	
Cooperation		e.g. number of contacts with other VO members	
Trustworthiness	e.g. number of tasks successfully completed		
Value Adding to past VOs (VA)	Sharing assets	e.g. number of different assets which a member shares in a VO	
	Reputation	e.g. number of Years in business, number of customers, size of market	
Special collaborative business Traits (ST)	Being Fair	e.g. number of disagreement on benefits distribution, either against the original contract, or against the consortium majority	
	Reuse of existing results	e.g. number of use and provision of references to other member's articles/results	
	Tolerance to stress	e.g. number of times pulling out of commitment	
	Being courageous	e.g. number of administration roles accepted, number of risks taken	
	Information sharing	e.g. frequency of information provision to other collaborators	

For example, when a VO planner wants to select a VBE member as a partner for a VO, different aspects of the past individual behavior of that member can be compared with others, according to different perspectives as exemplified by three perspectives presented in table1.

Furthermore, in order to assess the individual behavior, inter-relation among different traits/actions should be studied and well understood. In this work, causal relationships among different traits/actions are used to represent how they influence each other. To present this approach, consider the first perspective in Table1, conforming to past VO regulations. A causal diagram for this example is shown in Figure 1. In this causal diagram, the plus sign (+) indicates that the increase or decrease of the first factor causes the increase or decrease of the second factor, while the minus sign (-) indicates that the increase or decrease of the first factor causes the decrease or increase of the second factor [12].

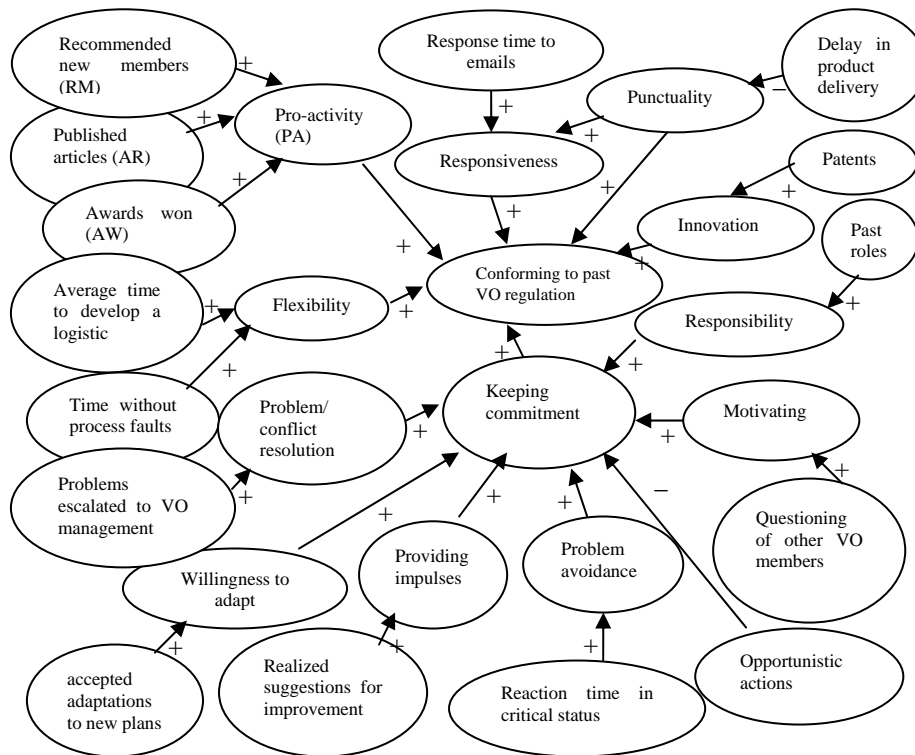


Figure 1: Quantitative analysis of relations among trait/actions using causal diagram.

Causal effects in Figure 1 represent the relations among different traits/actions in form of mathematical equations. By reasoning on the base of these causal relationships, some mathematical formulas can be derived to calculate values for comparative individual behavior of CN members. The plus sign (+) in the causal diagram represents either addition or multiplication, and the minus sign (-) represents

subtraction or division depending on the metrics that are related to the traits/actions. The selection of the correct arithmetic operator depends on the metrics that scales it and the balance of dimensions [13], [14]. For example, for measuring the rate of pro-activity (PA), it is needed to add the number of recommended new members (RM), number of articles in press (AR) and number of awards won (AW) as equation 1 shows:

$$PA = RM + AR + AW. \quad (1)$$

The derivative of equation (1) represents the rate of change of each of the factor with respect to time and the relations among the changes, as illustrated in equation 2. The integration of equation 2 provides the accumulation of PA, which represents the total rate of pro-activity for a period of time t_1 to t_2 (equation 3).

$$\frac{d}{dt} PA = \frac{d}{dt} RM + \frac{d}{dt} AR + \frac{d}{dt} AW. \quad (2)$$

$$\int_{t_1}^{t_2} \frac{d}{dt} PA = \int_{t_1}^{t_2} \frac{d}{dt} RM + \int_{t_1}^{t_2} \frac{d}{dt} AR + \int_{t_1}^{t_2} \frac{d}{dt} AW. \quad (3)$$

The rates of change as well as the accumulations equation for all factors in Figure 1 can be considered in the same way (according to their relationships). After that, there is a formula for measuring the rate of Conforming to past VO Regulations (CR). Also, it can be done for the other two mentioned perspectives in Table1 (VA and ST). Consequently, to calculate the final comparative behavior score for suitable partner selection objective, we should compute an average of weighted scores of all perspectives, as equation 4 illustrates:

$$Score = average (W_1 \times CR + W_2 \times VA + W_3 \times ST). \quad (4)$$

The weights (W_1, W_2, W_3) shall be defined by experts in the field, depending on the specific type of VO to be established. These weights should belong to the [0,1] interval and the sum of all these weights should be equal to 1. Finally, since we calculate the score for each member in the VBE, when a VO planner decides to select a most suitable member, she/he can compare how they rate against each other.

3 Network Collective Behavior

Analyzing and modeling the Network Collective Behavior which refers to how a group behaves as a whole and the factors which influence it, is more complex than

individual behavior. In fact, modeling collective behavior involves contributions from multiple disciplines.

Mechanisms, such as incentives and rewards, assessing of alignment of values and approach applied to the governance of a CN are factors affecting Network Collective Behavior of the CN. These factors are discussed respectively in the following paragraphs.

Incentives and rewards mechanisms may result in changes in the behavior of a CN. Networking sustainability through fair and transparent distribution of benefits, and addressing contributors' expectations are objectives of these mechanisms. The basis of the incentive system is on the motivation that a CN convinces its participants to be pro-active in relation to business opportunities.

The individual and Network Collective Behavior in a CN are influenced by the *value system* of network members. Therefore, it is important to identify the value system of the networks and their individual members to have an improved collaborative process. A CN consists of independent and autonomous entities which each of them has its own value system. Many conflicts among partners might come up because of misalignment of values. In the absence of identical value systems, the members' perceptions of the results of the collaboration processes may be different and consequently, they may show some non-collaborative behaviors, such as unwillingness to share knowledge and other inter-organizational disagreements [15].

CN Governance includes some structures, principles and rules for resources allocation and rights assignment. Moreover, it supervises the entities and activities within a CN. Governance and the behavioral aspects influence each other, mutually. The constraining rules of CN governance may lead changes in collective and individual behavior of network members, and also behavioral aspects such as character of a CN member influence the CN's governance.

For modeling the Network Collective Behavior, it is needed to identify the objectives, perspectives, traits/actions and metrics such as presented for modeling the individual collaborative behavior in the previous section. In this case, objectives may include improving: customer satisfaction, benefits to CN, CN achieving more power in the market/society. These objectives can be considered according to the two perspectives: financial and social perspectives.

4 Conclusion

Quantitative causal modeling is a powerful aid to understand and enable practical decisions about what might be the best action to take in a certain circumstance. Therefore, in our approach we measure the comparative individual collaborative behavior by using quantitative causal modeling. This approach could lead to identify or predict conflicts, select the best-fit VO members, assign the roles and rights in CNs more effectively, and measure the individual collaborative behavior in networks. Analyzing and improving the individual collaborative behavior of CN members will influence the Collective Behavior of the CN. According to our approach, partners' behavior could be compared with each other, and partners will be informed that enhancing their individual behavior will result in more success in their collaboration.

As such, improving the individual behavior through factors such as incentives and rewards as well as alignment of values and fairness in governance rules are proposed to influence the network's collective behavior.

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