FUZZY DECISION MAKING OF IT GOVERNANCE

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Abstract: IT governance implies a system in which all stakeholders, including the board, internal customers and related areas such as finance, have the necessary input into the decision making process. IT governance is the preparation for, making of and implementation of IT-related decisions regarding goals, processes, people and technology on a tactical or strategic level. But, the concepts of IT governance are broad and ambiguous which in turn implicate difficult and inaccurate assessments. In particular, the traditional handling of IT management by board-level executives is that due to limited technical experience and IT complexity, key decisions are deferred to IT professionals. This paper presents a fuzzy reasoning model for assessing IT governance complexity based on an extensive literature study. This model can be used for a good understanding how the concerns of IT governance behave, how they interact and form the behaviour of the whole system. The model for assessing IT governance is employed to compare how IT governance is defined in practitioners and Cobit.

1 INTRODUCTION

This paper suggests a collective behaviour model based on fuzzy reasoning with respect to IT governance concerns considered important in literature, and to represent how the concerns should be really addressed by practitioners and Cobit. Understanding how the concerns of IT governance behave, how they interact and form the behaviour of the whole system can certainly be interesting through this model. Factors such as concerns (and the number of them), interaction between concerns, environment, and IT governance activities can be equally interesting when studying “self-organized” IT governance systems, if the aim is understanding. But when we go about designing, a control system, we will be guiding its organization and we need to understand the complexity of the concerns and the emerging whole. Returning to complex interaction, we feel a need to attempt relating the system.

2 IT GOVERNANCE COMPLEXITY PROFILES

Complex system typically has some characteristic properties, but the extent to which a particular system exhibits any given property can vary. In this respect, IT governance complexity is a nonlinear mapping concept.

2.1 Domain Complexity

The domain complexity denotes a nonlinear function of what the decisions should consider. It comprises four complexity variables: goal, processes, people and technology. Goals include strategy-related decisions, development and refinement of IT policies and guidelines, and control objectives used for performance assessments. Processes include the implementation and management of IT processes, e.g. acquisition, service level management, and incident management. People include the relational architecture within the organization, and the roles and responsibilities of different stakeholders. Finally, IT governance is of course about managing the

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technology itself. The complexity variable technology represents the physical assets that the decisions consider, such as the actual hardware, software and facilities.

2.2 Scope Complexity

The scope complexity denotes a nonlinear function of different impacts implied by each decision. There is a long term aspect and a short time aspect of every decision that is made. The scope dimension is used to differentiate between different levels of decision-making. Firstly, there are detailed, rapidly carried out, IT-focused tactic decisions. Examples of tactic decisions include whether to upgrade a certain workstation today or tomorrow, how to configure a user interface that is only used internally, or the manning of a single IT project.

There also exists top management, low detailed, business oriented strategic decisions with long timeline. A strategic decision might consider whether it is most appropriate to develop an application in-house or to purchase it off the shelf, or how the performance of IT processes should be reported to top management.

2.3 Decision Making Complexity

The decision complexity denotes a nonlinear function of different steps required to make decisions within the different domains. This complexity deals with the relation between IT, and the models of the reality used for decision making. Before making any decision regarding e.g. the outsourcing of a helpdesk function, the organization must be clearly understood. Facts have to be thought over and investigated, and transformed into a model. The model might be a simple cognitive map, present nowhere else but in the head of the decision-maker, or a more formalized, abstract model put on print.

This process of analysis and understanding is denoted the understanding phase. Once the model is created, the actual decision can be made according to corporate IT principles, in a timely manner, by the right individuals, etc. In the IT governance definition, this is represented by the decision phase, which also includes planning of how to make the decision.

3 IT GOVERNANCE COMPLEXITY MODEL

The objective of this section is to understand the relationship between the complexity profiles and to construct a fuzzy reasoning model including the complexity of collective behaviour with respect to IT governance.

3.1 Relationship between Complexity Profiles

IT governance is not strict hierarchy. It contains lateral interactions that enable control to bypass the hierarchy. However, by focusing on an idealized control hierarchy it is possible to understand the nature of this structure. Such a focus will help in understanding the relationship between this structure and complex collective behavior. In an idealized hierarchy all communication, and thus coordination of activities, is performed through the hierarchy. Figure 1 denotes a hierarchical network structure. It describes the content of different statements identified in literature with respect to IT governance concerns.

Figure 1: Hierarchical Structure of IT governance.

This structure imposes a limitation (say, network weight) on the degree of collective behaviours of IT governance. This can be understood by considering more carefully the processes of coordination. The hierarchy is responsible for ensuring coordination of various concerns of IT governance. Lower levels of the hierarchy are responsible for locally coordinating smaller parts of IT governance and higher levels of the hierarchy are responsible for coordinating the larger parts of IT governance.

3.2 Fuzzy Reasoning Approach to Complexity Profiles

Fuzzy rules are usually formulated as IF-THEN statements, with one or more antecedents connected to a consequent via operators like AND, OR, etc.

IF ($Antecedent_1$) OP ($Antecedent_2$) … OP ($Antecedent_n$) THEN (Consequent) (w)

Here n is an integer, OP is standing for operators like AND, OR, etc., and w represents a weight value indicating the importance of a rule. In this study, our

fuzzy reasoning method is based on two assumptions as the following.

- Every activation of an input fuzzy set is regarded to be a piece of (fuzzy) concerns supporting the domain knowledge an expert formulated via rules and fuzzy sets.
- Each piece of concerns should be incorporated more actively in the decision-making process.

Table 1: Example of 3 steps.

	DM		
	low	*normal*	*High*
Domain	0.86	0.37	
Scope		0.77	
Accumulation	0.86	1.14	
Normalization	0.75	1.00	
Decision making	DM=DM_{normal}/1.00		

These assumptions can be implemented in 3 steps, concerns accumulation, normalization, decision-making. For example, Table 1 illustrates an application of 3 steps. The accumulation of the pieces of concerns produces: DM_{low}=0.86, and DM_{normal}=0.37+0.77= 1.14. Normalization of these values generates: DM_{low}=0.75, and DM_{normal}=1.00. The method therefore produces the outcome: DM=*normal*. This approach can be also applied to aggregation of the consequents across the rules, as there are many different weights indicating the importance of the rule.

When available computational capabilities are restricted by equipment size or cost, special attention should be given to defuzzification process. In these cases, the computational time must be reduced in order to improve the system performance. Hence, it is important to use fast defuzzification methods. As an alternative, faster and simple methods can be used such as finding the mean of maxima or by finding the half-area point. we presents a simple fast method for computing a centroid approximation by fitting the fuzzy output area into a triangular shape, see figure 2.

This approach consists in adapting any output shape into one single triangle. The computational time required by this algorithm is reduced with respect to that of the bisector method. This approximation gives the exact centroid position for any cluster shapes having a base length and areas ratio of 1 to 3. For fuzzy outputs not located at the origin, the triangular shape maximum position is located at the maximum output shape position. When the fuzzy output presents more than one maximum, the location of the triangle maximum is computed as the average of maxima.

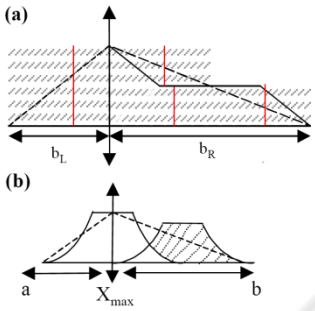

Figure 2: Output fitting to triangular function.

4 APPLICATION

Table 2 shows the results for these theoretical complexity variables, i.e. literature's concerns of IT governance. The total score for each dimension is 100%. Also, it includes the normalization within each dimension complexity, explained in previous section. Related to Domain complexity, twelve rules are defined in the rule base. We used the normalized rule weights for fuzzy pieces of IT governance concerns where many rules apply to the same conclusion, and used the simple fast defuzzification method in the previous section.

Table 2: IT Governance concerns according to literature.

Dim.	Complexity Variables	Literature Concerns	Normal
Domain	People	0.37	1.00
	Goal	0.26	0.70
	Process	0.20	0.54
	Technology	0.17	0.46
Scope	Strategy	0.70	1.00
	Tactics	0.30	0.43
DM phase	Monitor	0.42	1.00
	Decide	0.33	0.79
	Understanding	0.25	0.60

The theoretical IT governance concerns show that the dimensional variables "People", "Strategic", and "Monitor" were most frequently used within the 50 articles and within their dimensions respectively. IT governance mainly comprises strategic concerns according to literature. The daily use of IT, all the operational concerns for bread-and-butter IT are surely important, but they are not in the scope of IT governance. Regarding the decision-making phases, monitoring of IT-related decisions is emphasized. Technology issues are not the mayor concerns to

decide upon, and literature rather stresses the importance of establishing roles and responsibilities, and an accountability framework that supports the business goals.

In the Fuzzy DM of IT governance concerns, there are five parts of the fuzzy DM process: fuzzification of the input variables, treatment of the fuzzy pieces evidence, implication from the antecedent to the consequent, aggregation of the consequents across the rules, and defuzzification. Figure 3 only illustrates fuzzy sets for Domain complexity. The two variables have each been divided into 3 overlapping sets labeled Low, Normal, and High. The first vertical line represents a measurement of Process, which has a membership level of 0.2 in all the Low, Normal, and High sets, c.f. (Table 2). The second represents a measurement of Goal, which has a membership level of 0.26 in all sets. We can construct fuzzy sets of Scope and DM complexity in a similar manner. Related to Domain complexity, 12 rules are defined in the rule base.

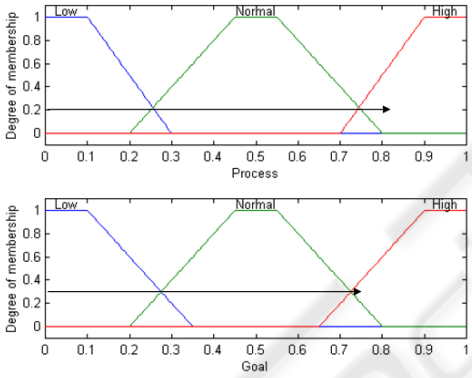

Figure 3: Fuzzy sets for Process and Goal in Domain complexity.

Figure 4 shows the surface plot between input variables of Domain complexity. Clearly it is evident from the plot that "People" is more significant than other input variables. IT governance concerns in Literature denotes that "Technology" is less significant than other ones. But, considered as a whole, "Process" is less significant than other ones, c.f. (Table 3). In particular, in proportion as "Goal" rises "Technology" concerns increase. Table 3 illustrates the comparison of values estimated by using four input variables.

According to the survey with practitioners, practitioner's concerns were mainly about IT goal setting, while IT processes and technology issues were less stressed. Table 4 illustrates the comparison of values estimated by our fuzzy model. Here, "Goal" is more stressed. Table 5 illustrates the

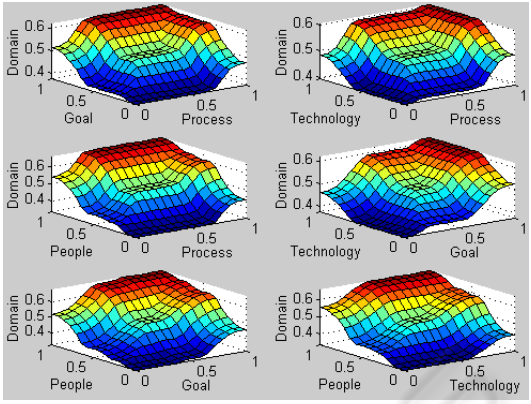

Figure 4: Mapping surface of Domain complexity.

Table 3: Comparison of values by fuzzy model.

Process	Goal	Technology	People	Domain
0.2	0.4	0.6	0.8	0.571
0.2	0.6	0.4	0.8	0.571
0.4	0.6	0.2	0.8	0.564
0.4	0.2	0.6	0.8	0.527
0.6	0.4	0.2	0.8	0.564
0.6	0.2	0.4	0.8	0.527

Table 4: Comparison of values by practitioners' concerns.

Process	Goal	Technology	People	Domain
0.2	0.8	0.4	0.6	0.536
0.2	0.8	0.6	0.4	0.536
0.4	0.8	0.2	0.6	0.527
0.6	0.8	0.2	0.4	0.527

comparison of values estimated by our fuzzy model. The result denotes that there is discrepancy in the range of the concerns identified in literature. Figure 5 shows the surface plots between input variables of DM and scope complexity, respectively. For DM complexity, the nine rules and normalized weights are included in the fuzzy rule system.

The theoretical concerns showed that the dimensional variable "Monitor" was more frequently used within the DM complexity. But, monitoring the implementation of decisions already made receives somewhat less attention from the practitioners, according to the survey. Also, comparing Cobit's concerns of IT governance to literature, it showed that Cobit does support most needs, but lacks in providing information on how decision-making structures should be implemented.

Table 5: Comparison of values by Cobit.

Process	Goal	Technology	People	Domain
0.8	0.6	0.2	0.4	0.492
0.8	0.4	0.2	0.6	0.492
0.8	0.2	0.4	0.6	0.460
0.8	0.2	0.6	0.4	0.460

Applied to our fuzzy model, the dimension variables of DM complexity are almost uniformly stressed. The relative concerns for the DM complexity remain a bit more uncertain. The difference seems to lie in their interconnection weights (and interactions) between the concerns of IT governance. For scope complexity, strategic concerns are most often dealt with, while tactical concerns are only briefly discussed. The six rules and normalized weights are included in the fuzzy rule system.

IT governance mainly comprises strategic concerns according to literature. According to the practitioners responding the survey, IT governance decision making is mainly a strategy issue while tactical decisions are less important. Similarly, Cobit spends more effort in discussing strategic concerns and less on tactical concerns. But, according to the mapping surface of Figure 5, strategic and tactical concerns that make up a large collective behaviour must be correlated and not independent.

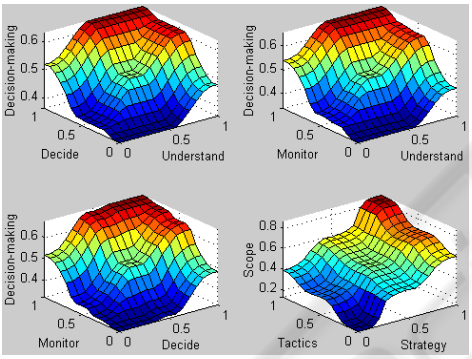

Figure 5: Mapping surface of DM and Scope complexity.

5 CONCLUSIONS

This paper presented a framework to understand the relationship between the complexity profiles in view of complexity science, and then developed a fuzzy reasoning model including the complexity of collective behaviour with respect to IT governance. It is necessary to understand the exact nature of the interconnections and how their weights give some effects on the behaviour of the whole IT governance. When there are such interconnections and they are not simple, a complex system can be used. In particular, IT governance complexity is a fuzzy concept. Thus, we suggested a fuzzy model for analyzing IT governance complexity based on an extensive literature study. IT governance concerns in literature were mapped onto the framework for this model, and a comparison study was carried out. Results showed that the major differences exist within the concerns of the domain complexity in the case of Cobit.

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