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Systems Approach to Business Rules

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Abstract

In traditional way of information system development everything was put into code. Every time a business event occurs the decision-maker needs to look into the 'code' for business rules to take a decision with respect to the business event. Therefore, access to the business rules to decision-maker is a problem. Every decision-maker may not and need not be software professional. The primary motive behind the business rules approach is to separate business logic from program logic
Software engineering professionals are addressing these concerns. To understand business rules approach in holistic manner and make it an effective tool for decision-making software engineering tools are not enough when the motive is to understand the business process and business dynamics and to help decision-maker take decision using business rules. This study uses systems thinking principles to address these issues. It uses cognitive modeling and interpretive structural modeling to understand the business process.

Key words and Phrases: business rules, business policies, causal map,

1. Introduction

Business rules approach to system development may not be a paradigm shift but it definitely undertakes a noticeable departure from the way information systems were developed traditionally. In traditional information system development writing software meant writing programs and generating code. Everything was put into code and a software system meant a body of code. In such a scenario system was accessible and visible thorough its code only and in no other way. This approach overlooked the fact that business decision-maker may not and need not be software professional. Business rules could pop up almost at every business decision making point. Which customer should be treated a privileged customer, on what basis an insurance policy should be renewed, how to reimburse insurance claim are some of the examples where business rules are needed to take decision. In the absence of any overt articulation of business rules a decision-maker has to look into the code to know them. You know there is a problem if you have to 'look at the code', for, there is no explicit statement about what business rules are. (Rosca, D. *et al* 1997). If business rules are imbedded into the code then the only way to get them out is by mining business rules through a kind of reverse engineering activity on software (Paul, L. 1995). Mining business rules through reverse engineering has two

problems. One, business rules might be scattered throughout the entire code and it may not be effective, in terms of cost and effort, to undertake this exercise. Two, reverse engineering for business rules may be based on assumption that code was developed with business rules in mind. This assumption may not be tenable. Whether or not business rules may be viewed as expressing functional as well non-functional requirements could be debatable and much depends upon how one defines business rules. However, requirements captured by business rules are, in principle no different from other kind of requirements. Business rules are characterized by their strategic importance to the business and deserve special attention (Rosca, D. *et al* 1997). If business rules are intended to facilitate business decision making then there must be mechanisms to make rules accessible to business decision-makers. ***This further requires that business rules are expressed in terms of enterprise level model and not in terms of programs and databases.*** (Loucopoulos, P. & Katsouli, E. 1992; Bubenko, J. and Vangler, B. 1993).
Business rules have received lot of attention in the trade press and other literature as holding answers to many information technology problems. (Sandifer & Halle, 1993), have even suggested that to begin with one can gather a list of English language statements describing the business rules informally as a good first step towards taking a business rules approach. Other approaches such as the one proposed by proposals are more structured, replying on the syntax of E-R diagram. Roland R., (1994), has proposed a much more elaborate diagrammatic syntax. Still others propose a conceptual model approach for describing an enterprise with a notation for specifying rules that further specify the requirement on the enterprise (Loucopoulos & Katsouli, 1992; Bubenko & Vangler, B. 1993). Martin and Odell (1995) limit the enterprise model to data and object rules. Some researchers treat non-functional requirements as goals that have to be met through a decision making process in which change is expected. Lamsveerde *et al*, (1995) propose a goal directed requirements elaboration methodology which attempts to cope with the 'deidealization of unachievable goals" and also models assumptions attached to goals. Fickas and Feather (1995), discuss requirement monitoring to instrument the running system to determine whether and to what extent requirements are being met by the system. Eventual aim of taking business rules approach to information system development is to automate the business processing through business rules. It is, in other words, aiming at compilable and executable specifications (Date, C.J., 2000).

2. Cognitive maps

In social science, cognitive map approach has been developed and used to catch holistic structure of knowledge on which decisions are grounded (Axelrod, R., 1976, Bougon, M., Weick, K., & Binkhorst, D. 1977, Eden, C. 1988, Kwahk, K.Y. & Kim, Y.G., 1999, Rai, V.K. & Kim, D.H., 2000). Cognitive map usually consists of variables and causal relations among them. In the cognitive map arrows interconnect variables. Direction of arrows means the direction of causal influence. And the signs attached to the head of arrows indicate the polarity of the causal relations. If two variables are connected by an arrow with + sign, it means the increase/decrease in the variable at the origin of the arrow causes increase/decrease in the variable at the head of the arrow. On the other hand if two variables are connected by an arrow with (-) sign, it means the increase/decrease in the variable at the origin of the arrow causes decrease/increase in the variable at the head of the arrow. With the variables and causal relations embedded in the cognitive map, one can see the emergent perceptual structure. The perceptual structure can then be analyzed to identify the perceptual bases of policy measures adopted by policy makers.

Cognitive maps do not represent precisely the algorithmic nature of human knowledge but they capture the abstract and holistic structure of human knowledge (Axelrod, R. 1976, Coyle, R.G. 1998). Although there are lots of indeterminacy in cognitive maps, they provide sufficient clues to understand the knowledge structure that produce decisions.

3. Business rules preliminaries

This section of the paper discusses the basics of business policies and business rules for the uninitiated. Every business enterprise has a set of business policies to govern its business behavior. Business policies are statement of course of direction a business enterprise should take to meet its business goals. Business rules are derived from business policies and are mechanisms to deal with various business situations and to introduce dynamism into the business procedures. They do this by defining or constraining some aspect of the business. It is intended to assert business structure or to control or influence the behavior of the business. Business rules are divided into five classes by researchers. *Definition rules*, which define a business term. For instance, consider the following rule. "IF the customer is a privileged customer THEN he may exceed his credit limit by 20%". Order processing clerk encounters this rule while processing customer order. This rule can not be executed unless it is determined what does businesses term 'privileged customer' mean and how it is defined. Consider the second rule. IF the customer's business transaction with the company is ≥ \$100000 per year THEN the customer is a 'privileged customer'. This rule defines the term 'privileged customer'. *Requirement rules* are defined in terms of imperatives. For example 'every employee must carry his/her identity card when in office'. *Fact rule* either connects a business object to another business object or it connects a business object to its attribute. The statement "customer has placed an order" is a statement of fact that connects business object 'customer' to another business object 'order'. 'Every customer order has an order number' is another statement of fact that connects business object 'order' with its attribute 'order number'. *Constraint rules*, the most familiar of all rules are expressed in IF-THEN-ELSE form. For example, IF room temperature is ≥ 30° C THEN switch on the AC. Finally, there are *derivation rules* which either derive new knowledge from given knowledge or infer new knowledge from given pieces of knowledge. For example, if a person's date of birth is given then his age can be derived using the formula, (age = current date – date of birth). Similarly, if an insurance policy is active then one can infer that policy period is not over yet.

4. Causal relations in rules

This section of the paper describes the causal relationship in IF and THEN rules in order to prepare a background for application of system thinking principles to business rules and rule based systems in general.

A causal map /cognitive map is composed of cause and effect relationship. A rule has also cause-effect like relationships between IF-clause and THEN-clause of the rule. If conditions in IF-clause are satisfied, actions in THEN-clause will be fired. In this sense, one can interpret that variables in IF-clause cause variables in THEN-clause. With this interpretation, one can construct cognitive map simply by connecting variables in IF-clause to variables in THEN-clause. However, one must remember fundamental differences between cognitive map and rules.

First, cognitive map represents continuous causal relationship, while rules represent discrete relationship between condition and actions. In the cognitive map, causing variables increase or decrease the value of caused variables. But in the rule, conditional variables only determine the activation of action variables. Relationships in the rule do not contain any continuous change of value of variables.

Second, rules are not fired continuously in time, while causal relationships in the cognitive map are supposed to work all the time. This means that the relationships between conditions and actions in the rule may represent a temporary relationship not constant causal relationship. Cognitive maps are focusing constant causal relationships to find the structural causal relationships that produce systems behavior. But if the relationships in the rule are only temporary, one cannot regard it as structural relationships.When converting rules to cognitive map, temporary relationships will complicate and confuse the perceptual structure.

Third, the relationships between condition and actions of a rule might go beyond simple cause-effect relationships. For instance, "If I am hungry, I will eat" rule means hunger-causes-eating. But, this causality is linear. However, if the reciprocal causality is introduced in the system by virtue of feedback the relationship “hunger-causes-eating” can be transformed in “eating-reduces-hunger” relationship. Therefore, the former that is “hunger-causes-eating” is feed-forward explicit knowledge while latter that is “eating-reduces-hunger” is implicit purposive knowledge coming from the feedback. Because of this feature in rule, one can find some hidden assumption regarding essential causal relationships by virtue of systems thinking.

Even though a rule can be interpreted as a causal relationships, these different features of relationships between rules and cognitive maps points out that rules cannot be directly translated into cognitive map.

5. Cognitive maps versus rule bases

Rules can be converted into a causal map with a following converting table. The conversion is performed by constructing graphic causal relationships from formal logic of a rule. As one can see in the table, there are basically two kinds of causal relationships (+/-) in causal map, while there are four kinds of rule. This means that some information might be discarded in causal map for simplifying purpose. Conversely, a causal relationship may also be converted into IF and THEN rule.

Relationships of a rule	Resulting Relationships in Action Map
IF A, THEN B	A (a) —+→ B (a)
IF ~A, THEN B	A (a) —-→ B (a)
IF A, THEN ~B	A (a) —-→ B (a)
IF ~A, THEN ~B	A (a) —+→ B (a)

Table 1. Converting rules to cognitive map

A cognitive map may be used as a technique to make explicit the cognitive structures on which decisions are grounded. It helps in

- ♦ identifying the underlying decision structure
- ♦ identifying the interrelationship among rules
- ♦ identifying the variables not apparent in the initial analysis

5.1 An example

We take an example to elucidate the benefits of cognitive maps in analyzing the system with respect to formulation of business rules. The example here pertains to London Ambulance Service (LAS) as discussed below. We take an overall view of the LAS system, for, an entire view will go beyond the scope of this paper.

London Ambulance Service (LAS): An example case

LAS is in charge of dispatching resources (ambulance, helicopters, etc.) to incident scenes. Some of the key objectives of the system are: to get the most appropriate resources to the scene of the incident (heart attack, a traffic accident, a terrorist attack, etc.) and get it there as quickly as possible (i.e. according to the standard that describes acceptable response time). In the format of manual LAS system before introducing a Computer Aided Dispatch System a call taker writes the details and identifies the location of the caller when an incident is reported. All the incident forms go to a central collection point where staff member reviews the details on each of them and decides what type of resources are needed for each incident and which resource allocator should deal with it. The resource allocator decides which resource should be mobilized and gives this information to a dispatcher who will pass the mobilization information to the appropriate resources (vehicles, crews, hospitals, etc.)

5.2 Initial Analysis

Following variables are extracted from the study.

- ♦ response time
- ♦ resource needs
- ♦ effective resource usage
- ♦ seriousness of the victim/patient
- ♦ distance from the site
- ♦ communication complexity/overhead

On a second look it may be noticed that one more important variable, ***"complexity of the accessibility of incident site"*** may also be considered, for, even if the site's ***physical*** distance is not much its complexity of accessibility may increase the ***effective distance***. Thus effective distance could also be considered as a variable. For instance, a helicopter or airplane might have crashed in a forest or a hilly terrain. Therefore, one may include this variable in the analysis of the system to design business rules. More importantly a designer would like to know the relationship among parameters and variables to understand the system needs and requirements. The causal map shown in figure 1 depicts the relationship.

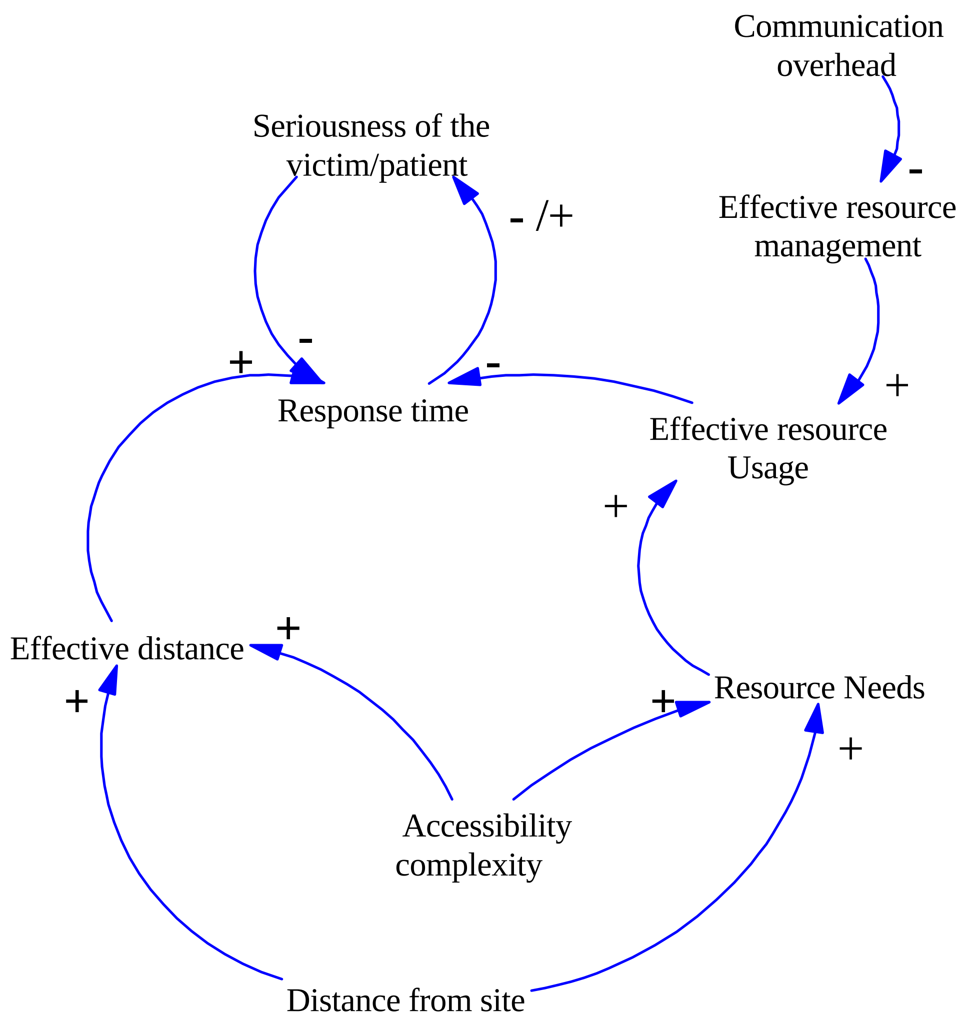

Figure 1. The cognitive map for London Ambulance Service

5.3 Analysis of the cognitive map

Cognitive modeling is used to arrive at the whole structure of the problem situation. It is not for analysis for case to case basis. It is a general mechanism to assure general effectiveness of the system. The analysis of the overview of the cognitive model of LAS is as follows.

5.3.1 The feedback loop: The feedback loop between seriousness of the victim/patient and response time could be either a positive or a negative loop depending upon the response time. The quicker the response time more alleviating effect it will have on the seriousness of the victim thus making the victim's condition less serious and vice versa. That means delayed response time will aggravate the victims/ patient's condition. This loop is the very fulcrum of the system. The positive nature of the feedback suggests that there will be no respite from this tight situation between response time and seriousness of the condition of the victim/patient. It is only the quick response time that will change the polarity of the loop into a negative one thus doing the balancing act. Furthermore, of all the parameters only effective resource usage supports (decreases) the response time. Other variable/parameters only increase it. ‘Response time’ is the most crucial variable in the entire system and is crucially connected to ‘resource need’. Effective resource usage reduces the response time, which is supported by effective resource management.

5.3.2 Other features of cognitive model

More the distance of the site from LAS and more the complexity of accessibility of the site more the time taken to respond (response time) and more resource need. More communication complexity and communication overhead less effective resource management. Each and every causal link can be converted into IF and THEN rule by the table given in table 1 above. Let us note that these rules will be very high level rules and they must be refined later.

5.3.3 Analysis in different areas of expertise

Expert analysis of the issues such as ‘seriousness of the victim’ is to be analyzed by the experts. The points of analysis could be whether it is a case of cardiac arrest and if yes whether it is fatal. Whether it is the case of head injury and how serious it is. Whether the injury has been caused by explosives or by other means? How serious is the victim’s condition is to be defined in terms of rules. What resources will be required is based on this analysis and also must be expressed in terms of rules. How quick should be the response time would also depend upon this analysis and would be expressed in terms of rules only.

For example,

Rule for resource

IF (diastolic blood pressure = high $\cap$ systolic blood pressure = high $\cup$ distance from hospital is < 30 km THEN send ambulance

Rule for response time

IF (injury = head injury $\cap$ blood pressure is high $\cap$ distance from hospital is > 50 km THEN response time = 30 minutes

Expert’s opinion will also be required in determining the shortest route to the incident site and so on. At this stage rules are refined to the extent that they are automated. The causal analysis helps only in getting the overall high level view of the system.

6. Another example

We take another example to elucidate other features of business rules using systems thinking techniques. We take the business process of health insurance policy renewal to demonstrate application of these techniques. First we define the problem statement and proceed further.

Problem statement

This study takes the problem of ‘insurance policy renewal’ by an insurance company. There are two major business policy guidelines for renewal of an insurance policy. One, if there is a standing order from the ‘policyholder’ then the insurance policy is renewed automatically. Two, if there is no standing order for renewal from the ‘policyholder’ then manual renewal process should begin. In case of manual renewal of the insurance policy the insurer must send a renewal notice to the policyholder at least 30 days prior to expiry date of the insurance policy. It is only when the policyholder accepts renewal and sends acceptance notice to the insurer that policy renewal process begins. In addition to business policies there are several renewal criteria based on which a policy can be renewed.

Some of the criteria are- Claim ratio of the policy, product portfolio performance, business considerations, customer satisfaction, risk-acceptability of the policy. In addition to these criteria there is a set of business rules attached to this business process. The rules are classified in the categories discussed above. Business rules are also grouped together along certain dimensions for the purpose of ease of processing them and also for the purpose of ease of decision making.

3.1 Capturing process knowledge into causal map

The following cognitive map describes the overall insurance policy renewal process. All important parameters and variable involved in the business process of policy renewal have been captured and a causal map has been constructed. The causal map helps the designer and requirement engineer in following ways.

1. It provides a snapshot of the entire process under consideration and helps understand the process
2. It depicts the interrelationship between process elements
3. Helps formulate high level business rules

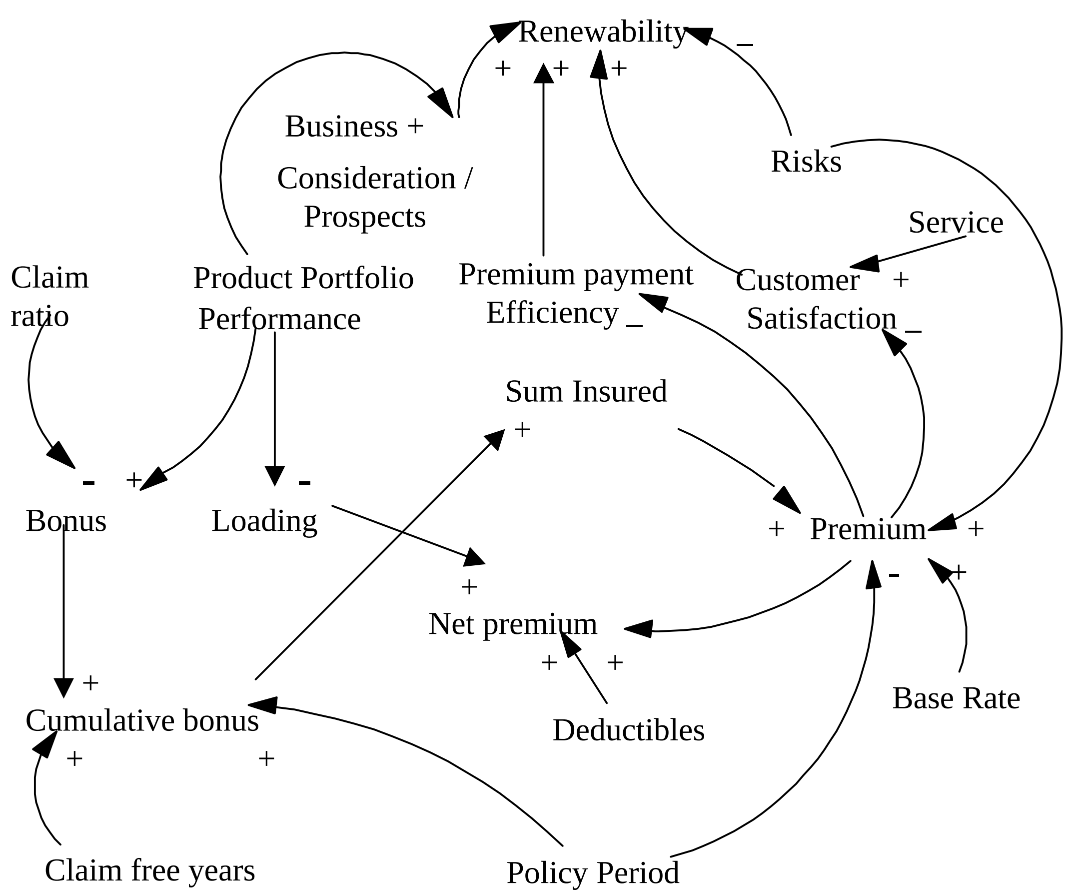

Figure 2: Cognitive map for insurance policy renewal process

4. Interpretive Structural Model for insurance policy renewal

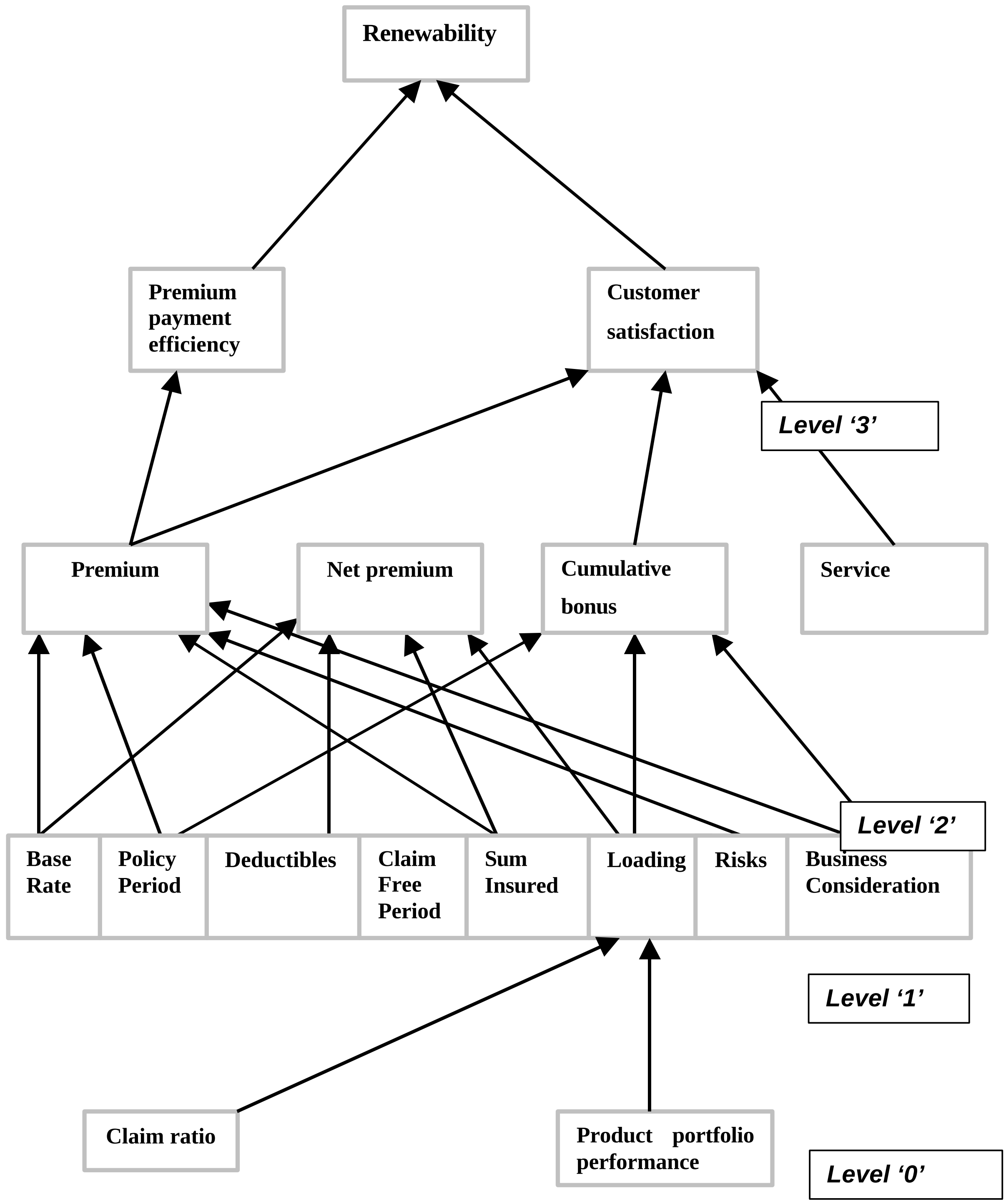

Figure 3: Interpretive Structural Model

Figure 3 shows an acyclic directed graph prepared using Interpretive Structural Modeling (ISM) technique. It shows the hierarchical layering of variables and parameters involved in decision making process for renewability of insurance policy. The layering shows the ordering of the variables / parameters in overall decision making process for policy renewal.

For instance, claim ratio occupies the ground / basic level ‘0’ in the hierarchy. The claim ratio is the first measure being taken into account while taking the decision about the renewal of a policy. This observation is verified by the study available on policy renewal. If the claim ratio is < 70% then policy is Okayed for renewal without taking into account other measures. However, if the claim ratio is > 70% then other measures need to be taken into account to decide whether or not policy is be renewed.

These layers show how decision making process with respect to the renewability of a policy is carried out in steps and what are the variables/parameters/measures at that level are to be taken into account. The other variable at this level is ‘Product Portfolio Performance’, another very important measure. Keeping everything else constant if the product portfolio in which the policy money is invested is not doing well, insurer may decide not to renew the policy. Variables at other levels i.e. 1,2,3,4 come in that order in the decision-making process. It should be noted that which variable a given variable is pointing to or connected to in the graph is not as important as the layering of the variables. Here the issue is the steps in the decision making process. For connectivity and knowledge acquired thereof please see the cognitive model given above in this paper.

6. Using cognitive map to connect derivation level rules

Domains like finance, banking and insurance have large set of business rules and processing them is a major task. To handle such a large set of rules are often grouped along several dimensions. Notwithstanding the ways one could group rules the fact remains that most of the rules are derivation rules involving calculations. Derivation rules are scattered throughout and there should be a mechanism to connect them. Causal maps could be used for this purpose. To connect derivation rules together. Figure 4 shows a causal map that connects derivation rules for insurance policy renewal process. This causal map helps the business decision-maker in following ways.

1. It shows the interdependence among variables involved in derivation rules and their determinants.
2. It shows data requirement for computing a given variable
3. It helps gather all derivation variables at one place so that decision-maker need not scan the entire document every time he/she needs to refer to them.
4. It helps in identifying business components / business blocks

For example one can figure out from this figure that the determinants of net premium are- loading, premium, deductibles and bonus. Premium in turn is determined by base rate, policy period and sum insured and so on. Formula for computing net premium is- Net-premium = premium – (deductibles - bonus + loading). As such it also shows data requirement for computing a given variable. Since relationships between variables remain the same and only data values keep changing one can build business components / software components and can use them across applications.

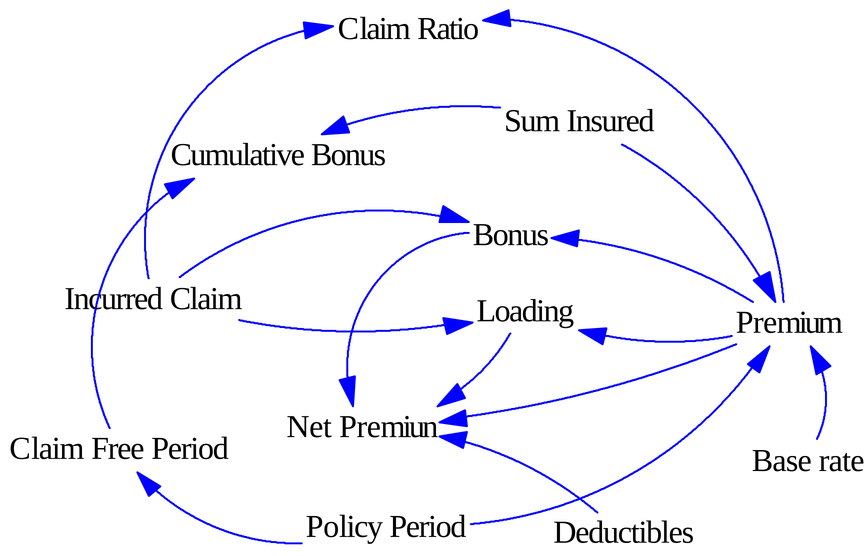

Figure 4: Causal map connecting derivation rules for insurance policy renewal

7. Conclusion

This is a very short and simple study the author has shown the usefulness of systems thinking techniques to understand enterprise system and business processes therein to help understand and formulate business rules. These techniques do help understand business rules in terms of enterprise system. This study takes two examples and shows the application of cognitive modeling and interpretive structural modeling techniques to business process analysis and business rules. This study can be further extended to use cognitive maps as a supporting tool to redesign and reengineer business processes.

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