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Abstract

This paper reports on a controlled laboratory experiment to test one of the important claims made for explicit rules analysis in performing Requirements Engineering. The general hypothesis tested is whether adoption of a Rules Base Approach to Requirements Engineering results in a set of conceptual models with fewer semantic errors than the status quo approach. The experimental findings support the hypothesis.

Introduction

A great challenge in designing and developing a computerized information system is to ensure it incorporates all the important organizational requirements. Much has been written about the failure of poorly designed systems to satisfy important requirements. This is not a new problem but a continuing one despite the search for better system development methods and modeling techniques.

Partly in response to this important problem a number of researchers which include Kapland (1997); Hurwitz (1997); von Halle (1993a, 1993b, 1993c, 1994a, 1994b, 1997a, 1997b, 1997c); Sandy (1994, 1996a, 1996b, 1998); Herbst (1994, 1995, 1996); Ross (1994); Moriarty (1993a, 1993b, 1993c, 1993d); Feuerlicht and Blair (1990, 1992); Loucopoulos (1991, 1992), and Sandifer and von Halle (1991a, 1991b) advocate the integration of explicit rules analysis with the commonly used requirements engineering methods. They argue that rules are at a higher level of abstraction than the data or processes. and therefore should be modeled first. This is because rules largely represent those requirements.

A search of the literature reveals that little empirical research has been undertaken to test the claims made for explicit rules analysis. This paper describes in outline the design, conduct and findings of a controlled laboratory experiment to test one important claim that is made. The approach adopted is referred to as a Rules Base Approach to Requirements Engineering. It is described in detail in (Sandy, 1998).

Briefly, the approach is based on An Organisational Rules Model which consists of five sub models. They are:

1. The nature of an Organizational Rule
2. Organizational Rule Types
3. Compound Rule Relationships
4. Organizational Rules Analysis
5. Relationship between the Conceptual Models, including rules.

Organizational Rules Analysis may be defined as a process which discovers, captures, classifies, models and validates an Optimal Set of Organizational Rules. The inputs to the process are the rules and knowledge about them. The output is the optimal set which may be defined as a complete, accurate, consistent and minimal set of Organisational Rules for a problem domain. The optimal set are stored and maintained in a Rules Base. Data and process (object) models are verified against the rules base.

The Research Question

The research question may be stated as What is the effect of using a Rules Base Approach to Requirements Engineering on the analysts ability to conceptually model the requirements for a problem domain? Specifically, Will this approach, compared to the status quo approach, result in fewer semantic errors? The research question can be stated as a series of hypotheses.

A Rules Base Approach to the conceptual modeling of organizational requirements will result in models:

Hypothesis 1a *with fewer semantic errors,*

Hypothesis 1b *better satisfy the criteria of completeness,*

Hypothesis 1c *better satisfy the criteria of minimality,*

Hypothesis 1d *better satisfy the criteria of consistency, and*

Hypothesis 1e better satisfy the criteria of accuracy than the status quo approach.

The Experimental Research Design

The type of research discussed in this paper is explanatory. This involves examining a cause-effect relationship between two or more phenomena. An appropriate research method for this type of research is a controlled laboratory experiment (Galliers, 1991; Shanks, 1993)

The design of the experiment is shown as Figure 1 “The Experimental Research Model”. Each of its components are now briefly described.

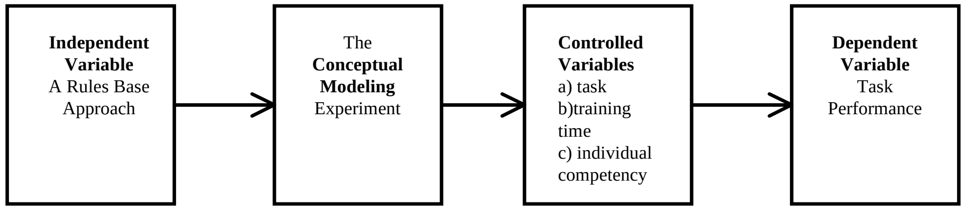

Figure 1. The Experimental Research Model

The Independent Variable is the use of a Rules Base for the task of conceptually modeling. A Rules Base is akin to a database and stores the validated organizational rules for a problem domain. The Dependent Variable is task performance. Each modeler subject is required to prepare a set of conceptual models which are complete, accurate, consistent and minimal.

The Conceptual Modeling Experiment tests whether adoption of a Rules Base Approach results in fewer semantic errors than a status quo approach. Semantic errors refer to the organizational meaning of the rules. They are compared to syntactic errors which arise from the incorrect use of a modeling construct. All modeler subjects perform the same conceptual modeling task based on a problem domain description. On the basis of the results (number of semantic errors) the subjects are ranked and the paired into a control group or an experimental group. Training in the use of a Rules Base is given to the subjects of the experimental group but this is denied to the subjects of the control group. Each subject performs the same conceptual modeling task based on a problem domain description.

The Controlled Variables are task complexity, task completion time, training content, training time and individual differences in task competency.

The Conduct of the Experiment

A Pilot was conducted and as a result some changes were made to training and accompanying documentation. In particular, the Pilot indicated that the completion time was insufficient. It was decided not to increase the time because it was thought that this would put at risk the willingness of subjects to participate in the experiment. Consequently, the requirement to prepare a data dictionary, which the Pilot revealed to be time-consuming was waived. It was considered that although this was undesirable it would not negate the efficacy of the experiment.

Twenty subjects additional to the Pilot, and all academic staff of the Department of Information Systems, Victoria University of Technology were invited to participate in the experiment. All agreed. All had successfully completed a unit at tertiary level, which included conceptual modeling, and most had “real world” experience. No subject had prior knowledge of a Rules Base Approach. Four subjects were unable to participate because of unanticipated work pressures or illness. Thus, after pairing and random assignment the size of the control and experimental groups were eight subjects. Successful use of logistic regression requires at least 8 pairings.

Analysis and Interpretation of Results

The criteria of completeness, accuracy, consistency and minimality are applied to each set of models prepared by the subjects of both groups. The total number of semantic errors and by error type is tallied for each pair of subjects. The results are analysed by applying a Logistic Regression Formula using a one tail test at the 95% level of confidence to discover if there is support for the hypotheses. Specifically, the probability (p value) of making an error was computed taking into account the pairing and group factors. Logistic Regression is a particular case of the generalised linear model. It is a parametric method, which is used here because the data is binomially distributed. This results from the binary response of the subject modellers of either making or not making the error.

A summary of the experimental findings is provided as Table 1 “Conceptual Modelling Experiment: Summary of Results” All p values are statistically significant and support the hypotheses 1a to 1d. Thus, modelers are able to use a Rules Base to ensure all important requirements are modeled. None are “missed”, nothing extraneous included, any inconsistencies are resolved and any distortion of the organizational meaning of a requirement is avoided. A Rules Base provides a valuable cross check with the data and process (object) models, and helps ensure all models satisfy the criteria of completeness, minimality, consistency and accuracy.

Conclusion

In conclusion, a Rules Base Approach to Requirements Engineering will increase the likelihood that all important organizational requirements will be incorporated in a system design. One reason why this is so is that this approach increases the likelihood that a set of conceptual models prepared by the analyst will satisfy the criteria of completeness, minimality, accuracy and consistency. As a practical outcome it is suggested that a Rules Base Approach be integrated with the commonly used requirements engineering methods.

Table 1. Conceptual Modeling Experiment: Summary of Results

Hypothesis	Task Performance P Value
1a	0.0003
1b	0.0038
1c	0.006
1d	0.023
1e	0.004

This research was necessarily limited in scope but its findings are claimed to reliable and valid. Specifically, it did not test the usefulness of a Rules Base Approach for the performance of tasks other than conceptual modeling. However, the research may be described as original and pioneering. There is however, a need to repeat the experiment so the findings can be generalized to a wider population.

References

A comprehensive list of references is available from the author (Geoff=Sandy@vut.edu.au).