Business Process Model and Business Rule Integration – Towards a Decision Framework

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Abstract. Information systems architectures are becoming increasingly complex and fragmented. As a result, organizations struggle to cope with change propagation, compliance management, and interoperability. Two major components in current information system architectures in terms of modeling business requirements are business processes and business rules. Although the need for business processes and business rules to be modeled in an integrated manner is well established, the body of knowledge on integrated modeling of the two is limited. To investigate in this topic, the Ph.D. project is divided into 4 studies. The first study aims to identify and evaluate what factors affect integrated vs separated modeling decisions. The second study aims to examine the effect of integrated modeling on process understanding. The third study aims to develop a decision framework that can guide business process modelers in making decisions about how to model a business rule.

Keywords: Business Process Management, Business Process Modeling, Integrated Modeling

1 Introduction

The modeling of business processes and business rules has been an important topic of Information Systems and Computer Science research over the last two decades [1, 2]. Business rules can be represented in an integrated manner or in a separated manner. By 'integrated manner', we mean graphically in a process model. In such integrated models, business rules can be represented either as text annotations (e.g. BPMN has a text annotation construct for such a purpose), as graphical links to external rules, or diagrammatically using a combination of sequence flows, activities and gateways. By 'separated manner', we mean rules constraining process activities are documented in separate documents or rule engines (in more advanced situations), and the relations and connections of business process models and the rules are not graphically represented on the process models. While all process models contain business rules in the form of control flow, additional rules are often modeled separately in documents or rule engines. In more recent years, as new modeling languages and methods have been developed [3], researchers have argued that business rules can be integrated into business process models [4]. Empirical findings [5] indicate that process designers often have the need to represent in a process model business rules that go beyond control flow rules, and a variety of integration methods and several guidelines have been developed [6–11]. Business rules can be represented in models either as text annotations, as graphical links to external rules, or diagrammatically using a combination of sequence flows, activities and gateways (see Fig. 1).

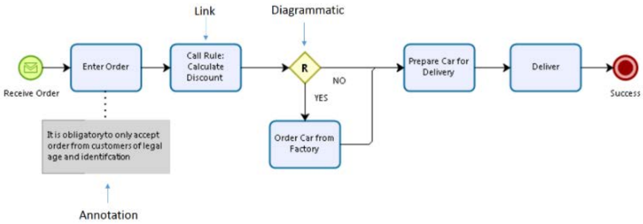

Fig. 1. Illustration of a business process model with rule integration

We argue, along the lines of [3], that there are situations under which a business rule is better modeled independently from a business process model, and situations under which it is more appropriate to integrate the rule within a business process model. It follows then that an important aspect of integrated modeling is the understanding of such situations and how they influence business rule representation. While the decision in regards to how a rule should be modeled is not a straightforward one, little guidance exists that can help modelers make such a decision. Thus, my first study aims to identify what factors affect such a decision, and to empirically evaluate the importance of the factors.

In addition to understanding the factors that affect the business rule modeling, it is also important to understand the effect of separated vs integrated modeling on the model user. Researchers have argued that model integration leads to improved process understanding, better communication, and system design, increased interoperability capacity, and better change propagation of new requirements and increased capacity for compliance management [12, 13], however, there is no empirical evidence for such argument. We argue that a good understanding of a process is a prerequisite to effective communication and design, and other benefits result from model integration. In particular, if and how integrated models improve the human cognition of the process represented is one of the most important research questions. Thus, the second study aims to investigate the effect of integration on process model understanding.

Understanding the factors that business rule modeling decisions and the effect of integrated modeling on the user then provides input in the development of a decision framework. Thus, the aim of the third study is to develop and evaluate a decision framework that guides modelers on whether to integrate a business rule into a business process model, based on research results from the first two studies.

2 Factor Identification and Empirical Evaluation

2.1 Methodology

To identify the factors that affect business rule modeling decisions, we conducted a systematic literature review based on a comprehensive set of well-regarded Information Systems and Computer Science journals and conferences (see www.aisnet.org and www.core.edu.au). Our data set consisted of 43,021 full-text articles (see [11] for further details). A full-text search was conducted using the term ‘business rule’. We regarded a paper as relevant if the keyword ‘business rule’ occurred 3 times or more within the body of the text and only selected those papers for the next round of analysis that met this criterion. Based on this elimination process, 255 relevant papers were identified. Each was then analyzed and identified as relevant only if a characteristic of a business rule (e.g. change frequency) was mentioned in the paper. This step resulted in the identification of 78 papers. The set of 78 relevant papers was then read in full and manually coded with a dedicated coding protocol implemented via an Excel spreadsheet (see [11]).

To evaluate the relevance of the identified factors and investigate their relative importance, we conducted an empirical evaluation with the authors of the 78 papers relevant for the factor identification being the target participants. The survey was designed, pilot-tested and revised through two iterations. With our finalized survey instrument, we collected 1) the importance of factors, 2) an importance ranking of the factors from each participant and 3) expert opinions on how rules should be modeled given each factor. We sent invitations to 112 authors of the 78 papers and received 22 usable responses, which represents a response rate of 23.08% when calculated as responses per paper.

2.2 Research Result

In total, twelve factors were identified. For further discussion of the factors, and the sources/papers in which they were identified, please refer to [14]. In the following, we provide a summary of the definition of each factor.

1. Accessibility refers to the user’s need to view and manipulate a business rule. If a stakeholder can easily view or manipulate a rule in a format that is suitable to his or her need, then the rule has high accessibility, otherwise, the rule has low accessibility.
2. Agility refers to how quickly a business rule can be adapted to a change. Rate of change deals with how frequently the rule needs to be changed, and agility deals with how long will it take for each change to be modeled in a rule.
3. Aspect of Change refers to the component of the rule that can be changed. The components of a rule that could change are the trigger condition, the reaction, or the values of parameters, as well as rule phrases and design elements.
4. Awareness of Impact refers to how comprehensively the implications of a business rule, or its revisions, are understood. Some business rules have a direct and clear impact, while other rules may have an indirect or unclear impact.

5. Complexity refers to the level of difficulty in defining or understanding a business rule. Some rules are simple and some rules can be complex in nature. Thus, the clarity and simplicity of business rules may differ based on the chosen representation.
6. Criticality refers to the importance of the rule. A violation of critical rules can lead to severe consequences for the organization, while a violation of non-critical rules may be less severe.
7. Governance Responsibility refers to who ensures that business activities are in accordance with business rules. Rules can be governed automatically by programs/systems, or manually by humans.
8. Implementation Responsibility refers to who is charged with implementing or updating the business rule. Both business users and technical users could be responsible for the implementation of a business rule.
9. Rate of Change refers to the frequency at which a business rule requires modification. Business rules can change in response to changes in regulations and policies.
10. Reusability refers to the potential for a rule to be used in new contexts. An existing business rule may be adapted or modified to fit new contexts and scenarios to reduce the resources required in developing new rules.
11. Rule Source refers to the origin of the business rule. Rule sources could be external or internal – e.g. laws and regulations or internal policies and standards.
12. Scope of Impact refers to the breadth of the impact of the rule. The impact of a business rule can be focused on an activity, an entire process, a department or the entire organization.

The evaluation consists of two parts. The first part refers to factor importance, and the second part refers to business rule modeling decisions. To distinguish the relative importance of each factor, we asked the participants to select at least 5 most important factors and rank them according to their relative importance. To calculate consensus between the participants, the rankings provided by all participants are aggregated into a single score. We adopted the classical positional Borda's method [14] to calculate the aggregated ranking, which is well adopted in literature [15, 16]. For details of the calculation method please refer to [17].

As shown in Table 1, *agility* is ranked as the most important factor, with 42 points, and *criticality* is a close second. The factors *rate of change* and *reusability* are jointly ranked third, with 37 points. *Accessibility*, *awareness* of *impact*, *complexity*, *governance responsibility* and *scope of impact* follow in that order. The lowest ranked three factors are found to be those of *aspect of change*, *implementation responsibility*, and *rule source*.

Table 1. Aggregated ranking using Borda's method [17]

Factor	Total Points	Rank	SD	Factor	Total Points	Rank	SD
Agility	42	1	2.05	Complexity	25	7	1.16
Criticality	41	2	2.19	Governance Responsibility	21	8	1.61
Rate of Change	37	3	2.00	Scope of Impact	17	9	1.79
Reusability	37	4	1.87	Aspect of Change	9	10	1.05
Accessibility	32	5	1.79	Implementation Responsibility	9	11	1.39
Awareness of Impact	27	6	1.73	Rule Source	2	12	0.31

While Borda's method allows us to identify the relative ranking, it is important to determine whether there is an adequate level of agreement between experts' individual rankings. The concordance of the rankings is an indicator of such agreement. We use *compactness* [18], to calculate the degree of agreement as suggested in [19]. The compactness of all the rankings is 0.36, resulting the degree of agreement among the participants' rankings is 0.64, which is deemed acceptable [19]. Table 1 also shows the standard deviation for each factor to provide an indication of the level of agreement on that factor.

In terms of the decision analysis, we first distinguish between 'affecting' factors and 'non-affecting' factors, i.e. no significant difference in expert opinion as to how that factor affects modeling, then analyze the affecting factors to determine modeling guidance given the factors' circumstances (see [17]). The modeling decision is analyzed for each circumstance of a given factor. Modeling guidance can be derived for the following seven situations:

1. When a rule has relatively high agility, it should be modeled independently.
2. When a rule changes frequently, it should be modeled independently.
3. When a rule changes infrequently it should be integrated into a business process model.
4. When a rule is highly reusable, it should be modeled independently.
5. When a rule's reusability is low, it should be integrated into a business process model.
6. When a rule requires relatively high accessibility, it should be modeled independently.
7. When a rule comes from an external source, it should be modeled independently.

3 Effect on Business Process Model Understanding

3.1 Theoretical Foundation

We look to existing theories of cognition science and information representation (for example [20–22]) to understand the effects of integrating business process models and business rules on user understanding of the models. The key arguments are as follows: (1) Due to the limit of working memory capacity and cognitive resources, a heavy cognitive load or cognitive overload typically creates errors, and the rate of error increases with the level of cognitive load [23]. (2) The form of information representation significantly affects cognitive load [21, 24]. (3) Static pictures and diagrams are more comprehensive and easier to make inference than sentential representations in terms of information explicitness and search efficiency [21]. (4) Information presented in an integrated manner is considered to reduce cognitive load, while split-source information can generate a heavy cognitive load in the process of information assimilation [22].

We introduce a cognitive process in the context of integrated process modeling as consisting of four stages, viz. *rule awareness*, *rule locating*, *rule comprehension*, and *information integration*. The stages are derived from a human information searching and processing cognitive model, where the information processing are in 5 stages, *viz. goal formation, category selection, information extraction, integration,* and *recycling* [25, 26]. In the following, we outline each of the four stages and provide related argumentation based on cognitive load and information representation theories.

Rule awareness: Researchers have found that it is a basic human cognition feature to be aware of information if indications of relevance are explicitly provided [27], and diagram, by its nature, can explicitly connect relevant elements together by placing the elements at adjacent locations, or by associate the elements using a variety types of lines [21]. Hence, we argue that it is easier to be aware of a business rule if explicitly integrated into a business process model.

Rule locating: By integrating a rule into a process model using link information, a stakeholder is able to find the correct business rules without searching the rule list comprehensively thus save cognitive efforts and avoid mistakes. Representing business rules as text annotations or diagrammatically will not require the effort of locating a business rule, since activities and rules are connected with association lines, or organized at adjacent locations.

Rule comprehension: Business process modeling languages generally have simple syntax and semantics, while business rules languages are often abstract, and have a logical syntax which requires some expertise for interpretation and modeling [28]. We argue that business rules integrated into business process models, using graphical constructs, can be better comprehended.

Information integration: By inserting a rule in an appropriate location on the process model and incorporating a rule and an activity into a single element by connections and links, the cognitive load of splitting attention, cross-referencing, and mentally information integration of different information sources are not required. Moreover, the explicit relations between rules and activities in an integrated graphical representation are able to map onto the relations between the features of the process being modeled in such a way that they restrict or enforce the kinds of interpretations that can be made, which makes perceptual inferences extremely easy.

3.2 Experiment Design

We hypothesize that the integration of business rules into business process models can improve the understanding of business processes. To empirically validate our hypothesis, we have designed an experiment with participants who have been trained in business process modeling in their courses. The subjects will be divided into two groups. A business process model and a set of relevant business rules will be given to the two groups, in an integrated manner and a separated manner respectively. In terms of measurements, we anticipate that besides traditional understanding performance measurements such as time to complete task and number of errors made, which only provide data on the overall performance, measurements that capture the process of cognition are essential. We will use eye-tracking devices, which can collect a variety of cognitive behavior data, such as eye-fixations, attentional switching, and scan path similarity, to explore empirically the effect of integrated and separated modeling of business processes and rules. This experiment is expected to be conducted in mid-2016.

4 Decision Framework Development and Evaluation

The design of the decision framework is still in its early stages. The decision framework is intended to guide process modelers in making informed decisions regarding which rules to integrate and how. The implementation of the decision framework will be through a web application. Before the actual use of the web application, a functionality and usability test of the decision framework will be carried out.

The evaluation of the decision framework includes experimental evaluation and empirical evaluation. The approach of how to evaluate the usefulness of the decision framework is difficult to finalize without finalizing the decision framework. However, it is expected that an experimental method will be appropriate. We will reach out to 3-5 organizations that have a suitable environment for business requirements modeling. Modelers in these organizations will then be invited to work guided by the framework through a series of activities that will collect both perceptionary as well as real data on use. We will then analyze this data to evaluate the usefulness of the decision framework for improving both the work practice of the business users as well as mitigating the disparity of business requirements modeling for the organization.

5 Expected Contributions

Following design science, my Ph.D. thesis will develop a decision framework and will contribute to practical knowledge on business process and rule modeling, conceptual modeling theory, information representation theory, and decision support systems. Expected contributions include: 1) practical knowledge of what factors impact integrated/separated business rule modeling decisions, 2) effect of business rule integration on process model understanding, and 3) a decision framework to guide modelers in regards to integrated vs separated rule modeling.

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