

Analysis of Business Rules modeling Approaches using 4-Dimensional Business Rule Framework

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Abstract— Business rules could be look at different perspective in Information systems. A 4-dimensional rule framework is developed to describe rules in Business, Representation, System and Application dimension. Each dimension is laydown by a set of attributes to capture the essential characteristics of business rule. Business dimension talk about how business rule is in actual business. Representation dimensional talks about how to represent rule so that business people can easily write and understand rules. System dimension deal with the characteristics of tool developed to manage and store business rules for Business as well as Technical audience. The attributes of Application dimension describe the characteristics of executing rules in actual software system. OMG accepted a standard, namely, Semantics of Business Vocabulary and Business Rules, SBVR and claim that it is meant for business people. The authors developed a business rule model, called, Business Rules Oriented Business Model, BROBM to provide a comprehensive solution, start from the capturing business rule as see in business till the actual software application. In this paper, authors did a detailed analysis of SBVR and BROBM based on the attributes of 4-dimensional business rule framework.

Keywords—Business rule, Business rule Manifesto, Business Motivation Model, 4- dimensional Business rule Framework, SBVR, Business Rules Oriented Business Model

INTRODUCTION

Business rules have been investigated intensively in the past by Information Systems and Knowledge management communities. In the former case, focus in on business rule extraction, representation, and make them available for software system/database system [10][21]. Where as in Later, business rules are used as a source of Knowledge representation and inference. The authors investigated business rule from Information system view. Further found that, the business rule in information system can be looked at either in business perspective or technical perspective.

The Business Rule Manifesto [18] reflected the business-oriented view of business rules and recognized business rules as a first-class concept for information system development. According to Manifesto, business rules are primary requirements, independent of processes and procedures, represent deliberate knowledge. Rules are declarative in nature and arise from knowledgeable business people. Further raised the need for tools to formulate, validate, and manage business rules.

BRG has also develop the Business Motivation Model, BMM [13], Semantics of Business Vocabulary and Business Rules, SBVR [13]. Now both are available as Standard in Object modelling group. SBVR is considered as a rule language to write rule form business perspective. Rules are written controlled natural language so that can be easily written and interpreted by non-technical business peoples. Beside SBVR, ACE [14] and RECONE [2] are two other controlled English languages used to write business rule as seen by business people. The authors also investigate these proposals and found the gap in representation of rules in SVBR and ACE. Further, developed Business Rules Oriented Business Model (BROBM) [5], by introducing the notion state in business rules, the temporal properties of business rules, rule typology to model atomic, complex and abstract structure of rule

While the technical view of rules focused on the enactment of business rule in software system. Here, two approached are used, 1) hardcode business rules in code of system written by any programming language, like JAVA, .NET, etc. 2) Manage business rule independently form the actual software code and execute rule using Rule Engine as and when required. The second approach has an edge over the first one

due to ease of maintenance of rules without affecting the actual software system.

The authors recognized Business Rules as multifaceted subject and proposed a 4-dimensional framework to better comprehend and communicate rules of an organization or system. The Framework is made up with Business dimension, Representation dimension, System dimension, and Application dimension.

- The business dimension describes the role of business rules in organizations.
- The representation dimension deals with the characteristics of the various forms use to express business rule.
- The system dimension defines the formulation, validation and management of business rules.
- The application dimension deals with attributes of business rules to support actual applications development.

For each dimension, authors identified 4 attributes. In this paper, the authors wish to do analysis of SBVR and own developed BROBM approach based on the attributes of 4-dimensional framework.

Rest of the paper is organized as follows, Section I contains the introduction of business oriented view of business rules. Section II contain the related work of business rule and presented brief introduction of SBVR and BROBM based rule representation system developed by authors. and Section III contain the 4-dimensional framework used to analysed of SBVR and BROBM, Section IV explain the analysis results and discussion, Section VIII concludes research work with future directions.

RELATED WORK

In this section, the authors describe the brief introduction of SBVR and BROBM in turns.

A. Semantics of Business Vocabulary and Business Rules

The OMG has developed Semantics of Business Vocabulary and Rules, SBVR [13], for structural and operational business rules. SBVR lays down the semantics of the business vocabulary as well as of business rules. The vocabulary consists of names, terms, fact types and keywords. Terms are used to designate noun concepts, for example, insurance company and policy holder whereas names refer to nouns that are instances of these concepts, for example, Life Insurance Corporation of India. Fact types capture n-ary relationships and use verbs to relate terms together. Keywords can be quantifiers, logical and modal operators etc.

Business logic is represented by business rules. At least one fact type is needed to create a business rule in SBVR. SBVR defines two kinds of Business rules: definitional rules and behavioral rules: Definitional Rules also called structural rules. They define an organization's setup. For Example, "It is necessary that each student have valid registration id" is a Definitional rule. Behavioral Rules named as operative rules obligate a given state of affairs(the conduct of an entity. For Example, a business rule, It is obligatory that maximum 5 books can be issue to each student for 15 days.

Semantic Formulation In SBVR, the semantics of a business rule are captured in SBVR as a logical formulation. The common logical formulations are [13]:

1. A fact type is specified by an Atomic formulation in a rule e.g. Atomic formulation "Student should be register" is derived from "Student is register" the fact type.
2. An instance of a class is denoting by Instantiation formulation e.g. The noun concept "Student" is Instantiated to "B.Tech Student".
3. SBVR also support the logical operations like, implication, negation, conjunction, disjunction, etc., create more complex logical expression.
4. Quantification also apply on a noun concept or verb concept e.g. "at least one", "at most one", "exactly one", etc are used to quantify concepts.
5. SBVR support the Modal Formulation to recognizes the meanings of a logical formulation e.g. "It is obligatory" or "It is necessary" are used.

SBVR comes with a structured English language for expressing business rules. An operational rule in Structured English specification:

It is obligatory that a UG student age should be at least 16 years.

Here, UG Student is a noun concept shown as underline. the verb concept is italicized i.e. should be; SBVR keywords and model are at least and It is obligatory respectively and 16 years is an individual concept.

B. BROBM

The authors studied the SBVR and found that it is position on CIM level of MDA architecture along with other proposal like ACE, RECONE. It had been claimed that these CIM level proposal is meant for business peoples but these proposals do not ask questions [5][16] while examine the business rule like

- What is the essential nature of business rules in a business?
- What is their structure?
- What are their properties?
- What are the inter-relationships between business rules?

The author proposed a model namely Business Rules Oriented Business Model (BROBM) for business rules from the business perspective and addressed the above asked questions [5].

After examine the course of action in Business Motivation model, the authors found that the structure of courses of action complement to the structure of business rules and found that business rule could be either ‘flat’/ non-hierarchical or Complex in nature. Further capture the enablement of a course of action by another is as additional relationship between business rules.

So, BROBM must have features for structuring business rules: complex rules would be defined over atomic rules and represent the enables relationship between business rules.

The third requirement is inferred form the End and Vision define in BMM, as

- End can be expressed in terms of states and
- Vision is about the ‘future state’ of a business.

As Changes in state are the outcome of courses of action and governed/guided by business rules we need to model states, state changes and their relationship with business rules.

The fourth of the business rules is temporal properties which found from the notion of the objective of BMM. Let see each in turns:

A. Business Rule Structure

A business rule structure is in two parts a) what is to be governed and b) how it is governed. Consequently, business rule (see Figure 1) as an aggregate of antecedent and consequent, in which the antecedent represents ‘how’ aspect the consequent ‘what’ aspect of the rule. As shown in figure a consequent is a business ac which may be either atomic and complex. A complex business act is composed of one or more atomic business acts. For example, purchase_material (book) is a business act built over the business acts Placing order and Pay respectively.

An antecedent may be a situation that is a state of the enterprise, a business act or any combination of these formed using the Boolean operators AND, OR, NOT. When antecedent is a business act then its enactment enables another business function for example of enablement is <Issue book, return book>, that is the enactment of Issue book enables the enactment of Return.

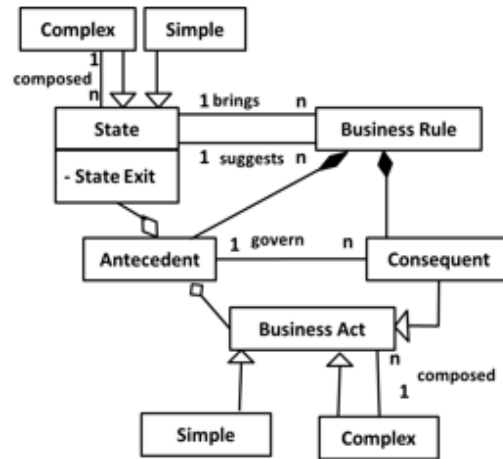


Figure 1. The Business Rule Model

B. The Notion of State

Now, consider the notion of a state. A state can be simple, that cannot be decomposed into simpler states, and complex, one that is composed of other simpler states. In other words, a state is complex if it uses conjunction or disjunction; it is simple otherwise.

When enacted, a business rule changes the state of the enterprise as shown by the relationship, changes, in the figure. The cardinality of this relationship says that the state of the enterprise can be changed by more than one business rule but a business rule changes only one (simple or complex) state. For example, the state, book availability, can be changed by two business rules for issuing a book (availability → issued) and returning a book (issued → available) respectively.

C. Typology of Business Rules

The Figure 1 did not, for graphical reasons, present the different types of business rules. This typology is shown in Figure 2. As seen there are three types of rules, atomic, complex, and abstract [5][16]. Complex and abstract business rules are constructed from simpler ones until atomic business rules are reached. Complex business rules are themselves of three kinds, aggregates, transitive rules, and bunches.

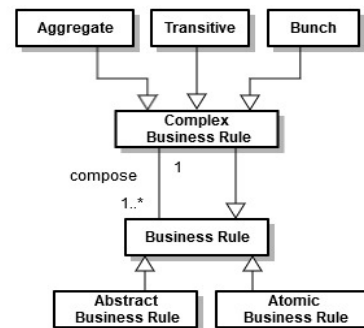


Figure 1. The Business Rule Typology

Examples of atomic business rule are as follows:

$\langle \text{Borrower.Type} = \text{'Faculty, Issue Journal'} \rangle$

In the first rule, the consequent, Issue Journal, is an atomic business act and its antecedent is a simple state.

Another example of Bunch complex rule, consider the collection of atomic business rules as follows:

- a) $\langle \text{Borrower.Type} = \text{'Student', Register Borrower} \rangle$
- b) $\langle \text{Borrower.Type} = \text{'Teacher', Register Borrower} \rangle$
- c) $\langle \text{Borrower.Type} = \text{'Administrator', Register Borrower} \rangle$

The Bunch formed is as follows:

Bunch

$\langle \text{Borrower.Type} = \text{'Student'} \text{ OR } \text{Borrower.Type} = \text{'Faculty'} \text{ OR } \text{Borrower.Type} = \text{'Administrator'}, \text{Register Borrower} \rangle$

Of

$\langle \text{Borrower.Type} = \text{'Student'}, \text{Register Borrower} \rangle$

$\langle \text{Borrower.Type} = \text{'Teacher'}, \text{Register Borrower} \rangle$

$\langle \text{Borrower.Type} = \text{'Administrator'}, \text{Register Borrower} \rangle$

D. Temporal Properties of Business Rules

As mentioned in the above, a business oriented business rule may be time-bound. The authors examine the temporal aspect of business rules and found that rules are either Instantaneous or Long running.

In former, antecedent and consequent of business rules occurs at the same where as in later, two possibilities exit, if end time of antecedent is grater then the start time of consequent execution and if end time of antecedent equal to the start time of consequent of business rule. The authors abstract out two temporal relations (BEFORE and MEET) introduced by Allen [1]. BEFORE is used to model first scenario and MEET to for second. To represent Instantaneous rule, We the authors introduced a temporal relation called INSTANT. To illustrate, let us apply temporal relations to Library business rule of a library:

If a student pays the library fee then the student is provided library service.

The antecedent and consequent of this rule is Payment and service provision respectively. The authors consider a few cases of the temporal relationships among these as shown in Table 1.

1) Representing UNTIL:

Another temporal issue is on the temporal constraint of state change. For example, "Journal could be issue for maximum 5 days". In this case if Journal is issued, it can be in issued state for next 5 days. The authors model this temporal

constraint on the state using UNTIL found in temporal logic [9]. UNTIL is defined as a binary operator, for example, (x UNTIL y). This says that x holds during the entire period when y does not hold i.e. talk UNTIL lecture end. In our example of a library, modeled as "issued UNTIL 5 days".

Table1. Temporal relationships

Antecedent	Consequent	Nature of Business Rule
Payment is instantaneous at time, t	Service provision is instantaneous at t	Instantaneous, INSTANT(A, C)
Payment is instantaneous at time, t	Service provision is instantaneous but after a delay at $t' > t$	Long running, BEFORE(A, C)
Payment is over an interval	Service provision is instantaneous but starts at end time of payment	Long running, MEETS(A, C)
Payment is over an interval	Service provision is over an interval but with a delay after end time of payment	Long running, BEFORE (A, C)

METHODOLOGY

In this section, the author will give a brief introduction of 4-dimensional business rule framework. Each dimension constitutes by its attributes.

A. The Business Dimension

Business dimension is laydown by combining the Business Rules Manifesto with the Business Motivation Model, BMM. The Manifesto described about "Principles of Rule Independence" [18], in BMM [3], The concepts of business governance and inter relationships between them is highlighted.

In BMM, business is defined through Ends and Means. Vision, Goals and Objectives are part of Ends whereas Mission, Courses of Action and Directives are Means. Visions achieve by laydown Missions. The goals are achieved through courses of actions, and objectives through directives. Directives govern courses of action and business policy and business rules are two types. So, Business rules /policy govern courses of actions of a business. Succeeding this, the authors identified two attributes namely, Guides and Contributes for the business dimension. Similarly, contributes comprises of one or more objectives to which it subsidizes.

These attributes are shown in the first and second rows of Table 2. Structure attribute depict about the form of business rule as see in business, a rule may be flat if atomic condition is verified otherwise become Complex. Role attribute obtained from the Manifesto. When rule execute, it updates the once or more state of business. It has been capturing through Enacting effect attribute. The Role finds whether the business rule is a main rule or an exception. Temporal property specifies whether the consequent executer

immediately after antecedent or wait for some time. Similar, how long business is in a state after business rule execution. SET is used where multiple value is exist.

Table 2. Business Dimension Attributes

Attribute	Value
Guides	SET{Course of action}
Contributes	SET{Objective}
Structure	Flat, Complex
Enacting effect	SET{State}
Role	{Main, Exception}
Temporal property	{Intra rule, State Exit}

B. The Representation Dimension

Representation dimension describe the form, nature and stockholders of the representation system. The Table 3 illustrate the attributes of the dimension.

There are two types of audience business and technical. The essential requirement for business audience is that rules should be declarative whereas for technical, the representation should offer 'main' rule along with all 'coping' mechanisms like errors, and compensations. The representation form of business rules is defined as second attribute. Here, IF-THEN [7][13][19] refers to Implication form of rules whereas WHEN-IF-THEN refers to event form and its other alternates as defined in [10].

Table 3. Attributes of the Representation Dimension

Attribute	Value
Audience	{Business, Technical}
Form	{Graphical, Logic based, Natural Language, Implication, Event}
Guidance	SET (Necessity, Obligation)
Enactment	{State Change}
Structure	Atomic, Complex
Temporal Relation	{Condition, Intra rule, State Exit}
Practicability	SET(Automated, Manual)

The attribute, guidance, is motivated form SBVR. For obligation, exist in SBVR, six enforcement levels is defined to show rule obligation in more depth. They start by defining strict rule and end rule as a guideline. The Practicability is again follows SBVR, may be automated or manual. Structure at Representation level shows weather Form used to write business rules able to model Atomic and/or Complex rule or not. Next attribute shows weather rule representation language have Temporal relations/operators to model time in antecedent, between antecedent and consequent, and the duration on which stage changes are effective. Practicability shows weather rule could be automate in actual software system or not.

C. The System Dimension

The nature of system is specified in System dimension, see Table 4 and needed to support the management of business rules. The type of business rules management support:

1. Decisional: In [17], Rules stored in data warehouse system that keeps information needed to decide whether a business rules is suitable or not.
2. Elicitation: If rules are maintained in external repository to support creation and evolution rule.

Users again depict about the user of the rules management system, business people or technical ones. It is multi-valued. The adaptable system welcome changes otherwise considered as fixed.

Table 4. Attributes of the System Dimension

Attribute	Value
Type	{Decisional, Elicitation}
User	SET{Business, Technical}
Evolution	{Fixed, adaptable}
Traceability	{Total, Objective, Course of action, None}
Portable	Boolean

Traceability is considered as fourth attribute. Traceability shows that whether every rule traced back to the objective it subsidizes to or the course of action it guides. If both objective and course of action can be trace back then considered as *total* Traceability; *objective* rules trace back to objectives; *course of action* when it traces back to courses of action; and it is *none* otherwise. Lastly, the capacity to store and organize rules independent of the software or hardware systems, refers to Portability defined in terms of YES/NO, a Boolean valued.

D. Application Dimension

The application dimension, describe the features of the platforms on which business rule applications run. The attribute discuss about the way in which business rules are executed in application. This can be through a rule engine [6], as a service [4] or as a procedure [20].

Table 5. Attributes of the Application Platform Dimension

Attribute	Value
Execution	{Rule engine, Service, Procedure}
Traceability	{Total, Objective, Course of action, None}
Evolution	Boolean
Portable	Boolean

Traceability talk about weather system rule is trace back to the objective it contributes to or the course of action it guides. Traceability is considered as *total* if it reflects both objective and course of action; *objective* traces back to

objectives; course of action traces back to courses of action; and otherwise has the none value. The Evolution attribute, state whether the business rules management system permits changes in legacy rules or not. Lastly, portability refers whether developed application can be moved from one hardware/software platform to another.

RESULTS AND DISCUSSION

Now let us put features of SBVR and BROBM in attributes of 4-dimensional framework, see Table 6. Start with the business dimension; BROBM have notion of course of action as the authors adapted Business rule guide/govern the courses of action” whereas notion of courses of action is missing in SBVR. Contribute attribute is supported by both SBVR and BROBM. SBVR have two types of role, main rule as well as exception rule to handle exception situation occur in business where as BROBM consider rule as main rule only, the exception situation is modeled as a separate main rule. SBVR consider rule as flat structure whereas BROBM recognize rule not only Flat but also Complex (build over the other rules) as well. The impact of business rule enactment is not considered in SBVR whereas BROBM recognized that the enactment of business rule has impact on the state of business entity. i.e. In Library, Issue Material business rule, change the state of Material form “Available” to “Issued” state. Further, Temporal properties between antecedent and consequent is not considered in SBVR whereas BROBM not only model this temporal relation but also recognized that the temporal constraint on state of business entity.

The focus of representation dimension is on the attributes to analyze the characteristics of the rule representation language. SBVR is meant only for the business people where BROBM provides Two level representation foe business and technical person. Conversion form business oriented rule representation to system oriented representation is integrated part which could be manage independently. SBVR have Structured English to write business rule and the sentence formation is base on logical formulation. In BROBR, the implication form (IF antecedent THEN consequent) which is semantically based on first order logic which was extended to introduce Temporal relation and notion of State. SBVR used modal logic (necessity and Obligation) to model the Guidance in business rule which is missing in BROBM. SBVR consider each rule as Atomic structure where BROBM recognized that rule structure is not only Atomic but also a Complex. Further, Complex is divided in Bunch, Transitive and Aggregate. Abstract rule is another form of rules which could be instantiated to the other types of rules. The impact of Enactment of rule on the business rules state is model using State Chane in BROBM rule which shows the current state of business entity and the new state after execution of rule.

Table 6. Analysis of SBVR and BROBM in 4-dimensiona rule framework

Dimension	Attribute	SBVR	BROBM
Business	Guides	-NA-	Course of action
	Contributes	Objective	Objective
	Role	Main, Exception	Main
	Structure	Flat	Flat, Complex
	Enacting effect	-NA-	State on Enterprise
	Temporal property	-NA-	Intra rule, State Exit
Representation	Audience	Business	Business, Technical
	Form	Natural Language,	Logic based, Implication
	Guidance	Necessity, Obligation	-NA-
	Structure	Atomic	Atomic, Complex: Bunch, Transitive, Aggregate, Abstract
	Enactment	-NA-	State Change
	Temporal Relation	Condition	Condition, Intra rule, State Exit
	Practicability	Manual, Automated	Automated
System	Type	-NA-	Elicitation
	User	-NA-	Business, Technical
	Evolution	-NA-	Adaptable
	Traceability	-NA-	Course of action
	Portable	-NA-	YES
Application	Execution	-NA-	Procedure
	Traceability	-NA-	Course of action
	Evolution	-NA-	YES
	Portable	-NA-	YES

SBVR consider time in its Structure English using date time keyword whereas BROBM recognized rule as Instantaneous and Long running in nature and used BEFORE and MEET temporal relation defined by Allen [1] to model intra-rule relationship of long running rules whereas for Instantaneous rule temporal operator INSTENT is introduced. UNTIL form the temporal logic [9] is used to model temporal constraint on state business entity. Further in antecedent of rule, the time is introduced a simple state variable/attribute of business entity. The Practicability is introduced in SBVR, automated refers to the operational rules whereas BROBM consider only automated type of practicability.

The authors opinion about System and Application dimension is that SBVR does any tool to store and manage rule and later directly enact them to real application. Although, there are few vender specific tool to write and manage SBVR tool. The authors developed rule management tool to store and manage rules in BROBM. Further to support the actual application development, Translation mechanism to convert business oriented rules write by BROBM into JAVA code is also part of Tool.

In BROBM, business rules are written and manage separately from application and considered as elicitation

type. Although the user of this level are business people but the technical folk also use the system to generate rules in Java. The rule management is considered to be adaptable as tool provides the capacity to evolve business rules and rules provide traceability to course of action. Being a Java based development platform, the tool is available for any having JVM installed. Rest of the attributes are similar to system as if rules evolve in rule management tool the new one's are available in application and trace back to the courses of action in the form of Java functions and obviously the developed application is portable as required JVM only to execute.

CONCLUSION AND FUTURE SCOPE

In the paper, authors discussed 4-dimensional frame work to view business rule as they see in business, representation system use to write business rule so that business audience can easily use it. A tool support to store and mange business rule for business people and how these rules make available for actual software application. The authors developed a comprehensive rule model, BROBM and did a comparison with well-established business rule standard SBVR.

The business rule enactment effect on the business entity state and introducing the temporal property is additional contribution of BROBM in business dimension. BOBRM contributed additionally. Although guidance to show whether business rule is necessary or obligatory is absent in BROBM at representation dimension. But, BROBM exploited the complex structure of business rule, introduced the state change and temporal relation and developed an extended first order logic base rule modelling language. The authors have not found the direct contribution of SBVR at system and application level.

Future scope of the work is including the model theory to BROBM to introduce the necessity and obligation of business rule at representation. Further there are few tools available to implement SBVR, the authors will further do an analysis of BROBM rule management tool with them.

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