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Abstract. Organizations constantly need to adapt to the rapidly changing macro environment. Information systems, that hinder and restrain flexibility, may jeopardize the ability for organizations to survive. A new method for developing information systems called the Business Rules Approach has emerged with promises of business agility. The Business Rules Approach focuses on business rules which are reliant on a Business Concepts Model for their structure and vocabulary. This paper examines the relation between the business rules and the Business Concepts Model. We conclude that a Business Concepts Model with less participation facts between terms generally yield less complex rules and that a Business Concepts Model with more participation facts between terms generally yield more complex Business Rules. However the tradeoff for decreased complexity is a loss of the ability to talk about or verbalize certain terms. We conclude that generalization facts in the Business Concepts Model do not impact complexity of Business Rules. Finally, the ability to express Business Rules in natural language is not impacted by increases or decreases in Business Concepts Model complexity.

Key words: Business Rules, Business Rules Approach, Business Concepts Model, natural language Business Rules, Business Rules Management Systems

1 Introduction

Organizations constantly need to adapt to the rapidly changing macro environment. Information systems, that hinder and restrain flexibility, may jeopardize the ability for organizations to survive. Over the last decade several authors have proposed the Business Rules Approach (BRA) as an Information Systems Development (ISD) method for achieving business agility (e.g. (Graham, 2006; Morgan, 2002; von Halle, 2002) The BRA focuses on Business Rules (BR). BRs are statements that define or constrain some aspect of the business and its behavior (Business Rules Group, 2000). BRs have the ability to make software flexible (Date, 2000).

The principles of the BRA are clearly stated in the Business Rules Manifesto. The BRA puts emphasis on BRs being treated as primary requirements in ISD (Business Rules Group, 2003; von Halle, 2002). BRs should also be expressed in a declarative manner, as opposed to a procedural manner (Business Rules Group, 2003; Morgan, 2002, Date, 2000). BRs are separated from process logic, thus achieving a separation of decision logic and process logic

(Business Rules Group, 2003). BRs are derived from business, and are owned by business people instead of by the IT department (Business Rules Group, 2003; Holmberg & Steen, 2010; Morgan, 2002).

The terms that BR statements contain are derived from the business environment. These terms are contained in a Business Concepts Model which holds a common ontology for terms used in BRs (Bajec & Krisper, 2005). The Business Concepts Model can serve as the basis for implementing natural language BRs in Business Rules Management Systems. The structure of the Business Concepts Model will thus determine the 'looks' of the implemented natural language BRs (Holmberg & Steen, 2010).
This paper aims to explore different ways in which the states of the Business Concepts Model influences BRs implemented in natural language.

Experiments were conducted using fictive Business Concepts Model examples as ground for our argumentation. We elected to use generic terms such as Employee, Order and Customer in our Business Concepts Models. This was not an attempt at mirroring a real organization and our focus was not on the authenticity of our Business Concepts Models, but rather an attempt to illustrate the effects the states of the Business Concepts Models has on BRs.

For our experiments we used a commercial Business Rules Management System (BRMS) that enables authoring, modifying, deploying and testing BRs. The elected BRMS uses a Business Object Model (BOM) made up of terms that will be used for writing BRs. The BOM also expresses participations between terms, e.g. an Employee (term) works (participation) at one or more Department (term). The BOM is generated based on an eXecutable Object Model (XOM). The XOM is a series of Java classes that can be manipulated in order to change the characteristics of the BOM. The XOM is generated from a graphical representation of the terms and associations modeled in an UML diagram.

The remainder of the article will be structured as follows: The next chapter will describe the BRA and how it is related to the concept of BRs. The third chapter will provide an in-depth description of BRs themselves. In the fourth chapter examples of fictive Business Concepts Models and their corresponding rules will be examined. The paper ends with conclusions.

2 The business rules approach

The Business Rules (BR) paradigm is grounded in the field of Databases, Unified Modelling Language (UML) and Artificial intelligence. BRs have been around since the earliest expert systems from the 1980s, where they were often hard-coded into the systems (Graham, 2006).

In the database research community an extensive debate on BRs can be found (Dayal, Buchmann, & McCarthy, 1988; Stonebraker, Hanson, & Hong, 1987; Widom & Ceri, 1996). Widom and Ceri (1996) proposed triggers and database procedures to facilitate BRs. Deductive database approach is another method that was proven to be powerful when dealing with BRs (Gallaire, Minker, & Nicolas, 1984; Petrounias & Loucopoulos, 1994).

While the BR paradigm emerged in the database research community, attempts were also made in the modelling tradition to support BRs by developing methods to visualize them. Several methods for BR modelling, such as the Ross method (Ross, 1997) or Structured Systems Analysis and Design Method (Downs, Clare, & Coe, 1992) were developed. Others proposed techniques to model BRs in a more well-known modelling language, called Entity Relationship Models (Tanaka, Navathe, Chakravarthy, & Karlapalem, 1991). Extending UML to allow BRs modeling has also gotten more attention. However, Bajec & Krisper (2005) state that UML does not provide sufficient guidelines for modelling BR. This is consistent with (Graham, 2008), stating that writing rules in class diagrams will not function in the BR perspective.

As BRs gained momentum in ISD, several authors contributed to the emergence of the Business Rules Approach. The Business Rules Approach (BRA) is a methodology and "formal way of managing and automating an organization's BRs" (von Halle & Goldberg, 2006, p. 5). The BRA forms a manual for the business to guide tasks, roles and activities. Governing processes using the BRA will improve business flexibility and efficiency; making it more dynamic and adaptable (Holmberg, 2014; Ross, 2003; van Eijndhoven, Iacob, & Ponisio, 2008; von Halle, 2002).
The BRA puts emphasis on IT projects being focused on solving business problems that stem from business needs, the purpose of the business is not to manage software but it is the purpose of the software to support business (Ross, 2003).

At the center of BRA lies the most important component, the actual BR (von Halle, 2002; Holmberg, 2014). The BRA rests on three main pillars.

Apart from the natural language and appropriate representation of the BR, the second basic principle of BRA is accessibility of BR by business users, managers, executives and so on (Morgan, 2002). The rules should be managed by the business users and not the technical staff (Business Rules Group, 2003). The BRA aims not only to involve and empower the business user, according to the Business Rules Manifesto, but also to provide access to tools that help them "formulate, validate and manage business rules" (Business Rules Group, 2003). Graham (2006) emphasizes that BRs are strongly business oriented. All BRs together capture the essence or business logic of the organization (Morgan, 2002). Therefore, BRs hold information and know-how of what is needed in a processes. For example, the process of offering discount implies action from the system or the employee, but both are guided by the associated BRs. The third BRA pillar emphasizes the importance of separating process logic from decision logic (Business Rules Group, 2003). This is a line of thinking that has been pervasive in BR paradigm, even in earlier works by Layzell and Loucopoulos (1988).

3 Business rules

Business Rules (BR) have been defined using different terminology by many authors (e.g. von Halle, 2002; Morgan 2002; Ross 2003). The definition that will be used for this paper is:

"A statement that defines or constrains some aspect of the business" (Business Rules Group, 2000, p. 4).

BRs are often found in organizations' internal documentation, in tacit know-how, in systems and in records (Morgan, 2002). The report by Business Rules Group (2000) assumes that BRs stem from business policies.

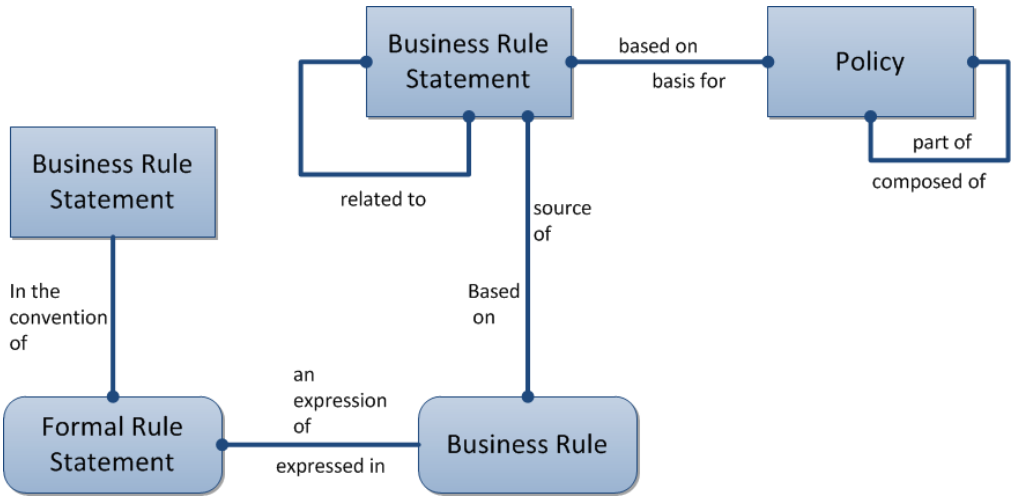

Figure 3.1: The origins of Business Rules (Business Rules Group, 2000, p. 10)

Figure 3.1, a part of the overall Business Rules Model, illustrates a breakdown of the components and origin of a BR using the given definition from the Business Rules Group. The Business Rules Group has provided a Business Rules Model, detailing different types of BR, what they are composed of and how they interrelate. Figure 3.1 shows that organizations have policies, which state the overarching goals of the organization (Business Rules Group, 2000). A fictitious example of a policy would be: We strive to provide excellent customer service. These policies in turn may consist of a number of more specific policies (Business Rules Group, 2000).

Policies serve as the basis for declarative business rule statements. A statement based on the aforementioned policy could be: A customer must be served within 20 minutes of calling and should have their call transferred a maximum number of 2 times.
The business rule statements state a goal to be achieved, but leave out how to achieve the said goal. In other words, the business rule statements explain the 'what', as opposed to the 'how' (Morgan, 2002; Date, 2000). This business rule statement can in turn be broken down into *atomic BRs* (Business Rules Group, 2000). Atomicity implies that BR cannot be broken down further without loss of information (Business Rules Group, 2000; Morgan, 2002). An example of an atomic BR derived from the previously mentioned BR statement could be: A customer must be served within 20 minutes of calling.
These atomic BRs can be expressed as *formal rule statements*. Guidelines on how to craft these formal rule statements are given by, for example, Morgan (2002) whose guidelines will be used to create formal rule statements in this paper.
The formal rule statements are expressed in a *formal expression type* which entails that all BRs will be written down in the same way. Formal expression types may take many forms, such as a pseudo code structure called ECAA (Event, Condition, then-Action and else-

Action), proposed by Herbst (1996). Other examples are the If-Then-Relationship structure used by Loucopoulos and Layzell (1989), or Business Action Language.

BRs in the Business Rules Model are divided into three sub categories: structural assertions, action assertions and derivations (Business Rules Group, 2000). This categorization is reflected in many other works such as von Halle (2002) and Morgan (2002), although the names of the categories differ, in practice they are similar.
Action assertions place constraints on the actions of a business (Business Rules Group, 2000). An example of an action assertion would be: A customer must not be serviced unless the customer provides a valid customer number.
*Derivation*s are statements of knowledge derived from other such statements (Business Rules Group, 2000). An example of a derivation would be for example "The total price of an order is defined as total product price plus shipping costs".
Structural assertions can be divided into *terms* and *facts* (Business Rules Group, 2000). Terms in a structural assertion refers to the existence of something that is important to the business (Business Rules Group, 2000). An example of this could be the terms Employee and Customer. Facts in structural assertions are sentences that specify different types of relationships between two or more terms (Business Rules Group, 2000). An example of a fact would be: an employee works at one office. The previously mentioned fact states a *participation*, also known as *association* or *relationship*, between the two terms Employee and Office. Facts can also express that one term is an attribute of another, for example: an employee has a name would suggest that the term Name is an attribute of the term Employee. The third type of structural assertion is the *Generalization* which states that a term is a supertype of one or more other terms, which are regarded as its subtypes (Business Rules Group, 2000). An example of a generalization would be: an office clerk is an Employee. Structural assertions specifically can be thought of as a list of BRs, which detail how the different elements fit together. BRs are often visualized using some sort of business vocabulary or entity relational modeling notation, resulting in a Business Concepts model. The Business Concepts Model, according to Bajec & Krisper (2005) contains a common vocabulary of terms used by the entire business.

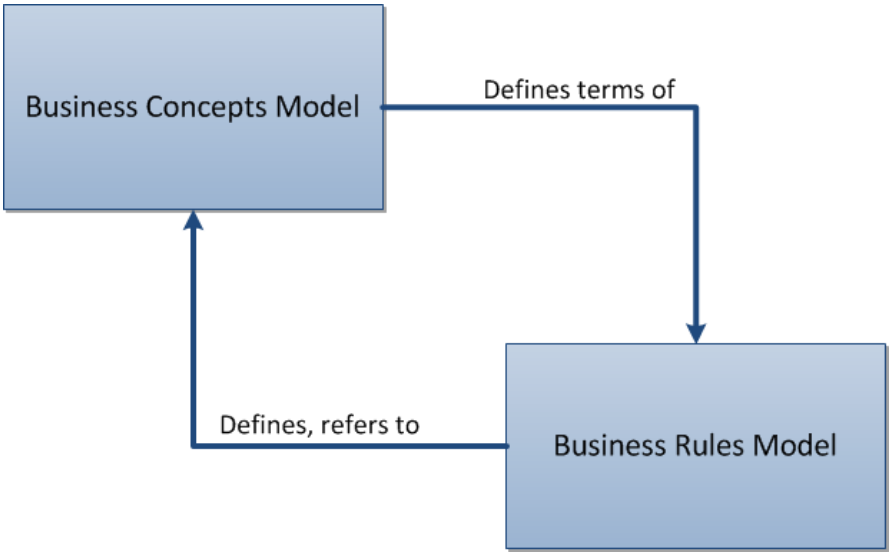

Figure 3.2: The relationship between the Business Rules Model of Business Rules Group (2000) and the Business Concepts Model of Bajec & Krisper (2005)

Since the structural assertions govern the existence of terms and their interrelations; the Business Concepts Model is defined by the terms and facts that make up the structural assertions in the Business Rules Model. The Business Concepts Model in turn holds the terms and facts used in other categories of BRs, such as action assertions and derivations in the Business Rules Model (see figure 3.2).

4 Designing Business Rules

So far BRs have been described on a conceptual level. However, in order to implement natural language BRs, a computer that understands natural language is required. This can be achieved by providing the computer with an ontology in the form of a UML model, which supplies the vocabulary on which BRs are built (Graham, 2006).

Thus it is required that we transform our Business Concepts Model into a UML model that can later be used for generating code. For illustrative purposes, consider the following structural assertions:

A customer can place many orders
An order belongs to exactly one customer
An order contains many products
A Product can be included in many orders
A product is produced by exactly one manufacturer
A manufacturer can produce many products
A manufacturer is supplied by one supplier
A supplier can supply many manufacturers

These action assertions can be represented in UML in the following fashion:

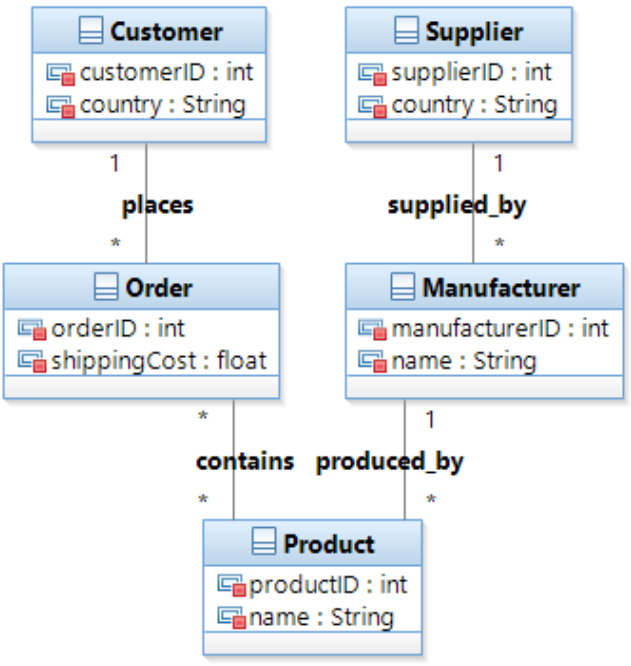

Figure 4.1: A Business Concepts Model

The next step involves implementing said rule-containing model in a Business Rules Management System (BRMS). A BRMS is required to do things such as testing and deploying implemented BRs. We used a commercial BRMS called IBM Websphere Ilog JRules. The formal expression type used by our BRMS is called Business Action Language (BAL). In order to be able to write BRs in BAL a Business Objects Model (BOM) containing the ontology, that is the terms used for the BRs, is needed. This BOM is acquired by feeding Java classes into the BRMS to form a so called eXecutable Object Model (XOM) that in turn is used to generate the BOM. We did this by using IBM's Rational Software Architect 9.0 containing a representation in UML of our Business Concepts Model and having it convert that UML model to Java classes. The workflow is illustrated in figure 4.2

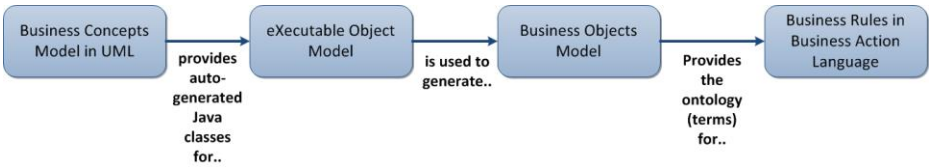

Figure 4.2: Workflow from Business Concepts Model to implementation of BR

As established earlier, the structural assertions of the Business Rules Model make up the Business Concepts Model, which in turn govern the terms used in action assertions and derivations. This relationship will now be tested by introducing an action assertion BR:

Rule 1: A customer ordering products produced by a supplier from the same country as the customer must not pay shipping costs

Implementing this action assertion based on the Business Concepts Model given in figure 4.1 yields the following BR:

```
definitions
    set 'current customer' to a customer ;
    set 'current order' to an order from the orders of 'current customer' ;
    set 'current product' to a product from the products of 'current order' ;
    set 'current manufacturer' to the manufacturer of 'current product' ;
    set 'current supplier' to the supplier of 'current manufacturer' ;
if
    the country of 'current customer' is the country of 'current supplier'
then
    set the shipping cost of 'current order' to 0 ;
```

Figure 4.3: Rule 1 implemented in BAL using the Business Concepts Model of figure 4.1

The way that the rule is designed is dependent on the structure of the Business Concepts Model. This is illustrated in figure 4.2, since each new step relies on the output of previous step. Thus, changes in the Business Concepts Model will ultimately be reflected in the BRs (Holmberg & Steen, 2010). Consider the same Business Concepts Model as in figure 4.1, with a few changes:

Figure 4.4: A 'shrunken' representation of the business concepts model of figure 4.1

Note that the two Business Concepts Models, while looking radically different, keep the same general concepts intact. The information of the term Customer still exists, but it is represented in the attributes of the term Order as opposed to being a term on its own. Five participation facts of the Business Concepts Model have been lost; these too are expressed as attributes of either the term Order or Product. The facts that state the attributes previously belonging to the term Supplier are now stating them as being attributes of the term Product. The model in figure 4.4 thus maintains the overarching fact stating, that a product can only be supplied by one supplier, as it has only one set of supplier attributes. In shrinking the model, terms are removed and the facts that determine their attributes are modified. The new facts determining attributes point towards another term than the one that was removed. In this way, terms and participations are removed, and the Business Concepts Model seemingly shrinks.

This demonstrates that, when the Business Concepts Model is changed, BRs are altered. In this case the facts regarding attributes, terms and participations changed as a result of changes in the Business Concepts Model.

Attempting to create the same business rule, displayed in figure 4.3, with the Business Concepts Model displayed in figure 4.4 yields the following result:

```
definitions
        set 'current product' to a product from the products of the order ;
if
        the country of the customer placing the order is the country of the
        supplier of 'current product'
then
        set the shipping cost of the order to 0 ;
```

Figure 4.5: Rule 1 implemented in BAL using the Business Concepts Model of figure 4.4

The consequences of a shrunken Business Concepts Model are now directly visible in the business rule seen in figure 4.5. The rule in figure 4.3 needs to have each of the terms defined, if they are to be used in combination with each other. For example, when using the customer's order, the variable 'current order' had to be defined. The BR in figure 4.5, belonging to a Business Concepts Model having lost several terms and participations, does not need to pre-define those very terms that were removed. However the consequence of losing the terms also implies the loss of the ability to verbalize them. Note that in the latter rule Customer is simply a part of the verbalization of the Country attribute in Order, because that attribute pertains to the origin of the customer making the order, as it was previously an attribute of Customer.

So far the effects of participations and attributes on BRs have been explored. In order to deal with what Business Rules Group (2000) calls generalizations, the Business Concepts Model in figure 4.4 will be modified to include a sizable inheritance hierarchy. The following structural assertions will be added to the Business Concepts Model:

Spare Parts is a Product
Vehicle is a Product
Boat is a Vehicle
Car is a Vehicle
Police Car is a Car
Civilian Car is a Car

The added supposition that comes with the new structural assertions is that the fictitious business that the structural assertions describe is in the business of selling cars. Adding these structural assertions will impact the Business Concepts Model as shown in the following UML diagram:

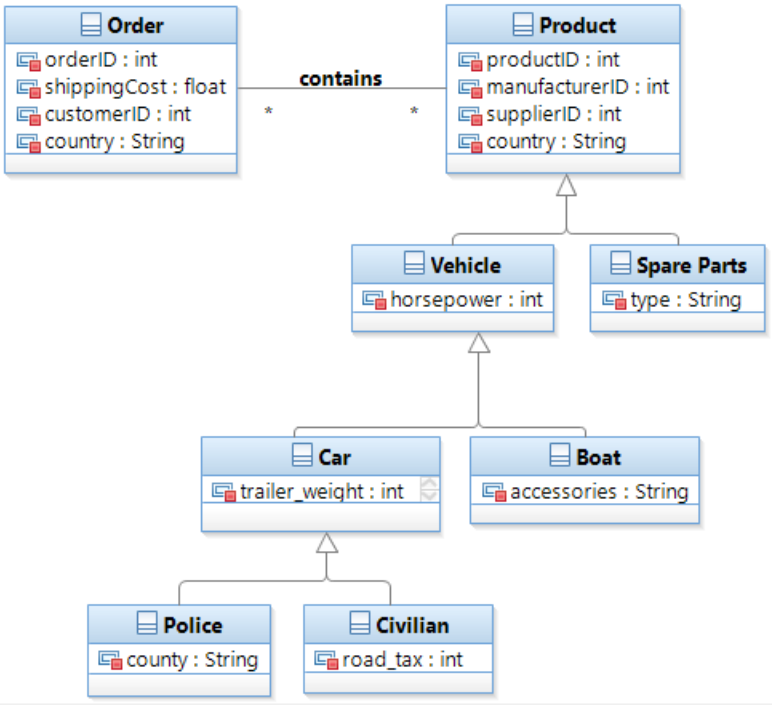

Figure 4.6: The Business Concepts Model from figure 4.4 with added generalizations

The different subtypes to product may seem to add complexity to the Business Concepts Model. While this might be the case, the impact on BRs based on the model is negligible. In order to demonstrate this, the same rule shown in figure 4.3 and figure 4.5 will be implemented with a slight modification. The slightly modified version of Rule 1 that will be stated below as 'Rule 2' only applies to police cars:

Rule 2: A customer ordering police cars produced by a supplier from the same country as the customer must not pay shipping costs

```
definitions
    set 'current product' to a police car from the products of the order ;
if
    the country of the customer placing the order is the country of the
supplier of 'current product'
then
    set the shipping cost of the order to 0 ;
```

Figure 4.7: Rule 2 implemented in BAL using the Business Concepts Model of figure 4.6

Comparing figure 4.7 and figure 4.5 the only discernable difference in Rule 1 is a change in the set clause from using the word 'product' to using the word 'police car'. Introducing generalizations into the Business Concepts Model would thus not seem to increase complexity in BRs. The reason for the lack of increased complexity is the ability to use subtype terms interchangeably with supertype terms. In the case of a participation fact, the association between two terms has to be explicitly expressed as, for example: 'the order of the product'. Since terms in generalizations can be expressed interchangeably, there are no resulting complex wordings. Complex wordings such as 'set current product to a product that is a vehicle that is a car that is a police car' are not present due to the fact that a product is a police

car. The term ‘Police car’ can be talked about specifically without having to mention the other terms in the generalization hierarchy.

As previously mentioned, the Business Rules Manifesto clearly states that BRs should be managed by business people. When defining the terms of a BR, the person that has to create the definitions for all the BRs would benefit from having a clear overview of the terms, facts and relationships related to the BRs. This person would, for example, question whether Product has a connection with Supplier, or does the connection go through a number of other terms, such as Manufacturer? In answering these questions we argue that it would be helpful to the user to have a clear visual representation of the Business Concepts Model. Any user attempting to define the terms of a formal expression type of this kind would potentially have great difficulty, when the corresponding Business Concepts Model is compact and hard to interpret correctly.

However, the number of terms needing to be defined seems to be decreasing, when the complexity, reflected in the number of terms and participations in the Business Concepts Model, decreases. Thus we end up with two extremes: A ‘business rule friendly’ Business Concepts Model as proposed by Holmberg & Steen (2010) demonstrated in figure 4.4. The second option is a ‘not so business rules friendly’ Business Concepts Model as shown in figure 4.1. The second type of business model still facilitates declarative natural language BRs as demanded in the BR manifesto. However it may lack the manageability that the BR manifesto also requires.

The choice of model here may seem tilted in favor of the less complex model. However what must not be forgotten is that the BRA emphasizes the primary focus on business needs. If there is indeed a need in an organization for a Business Concepts Model that resembles the model used for persistent data storage, then the ‘rule friendly’ Business Concepts Model may need to be discarded for a more complex one. When the business demands a model that is less ‘rule friendly’ there may be need for a decision on what degree of manageability the business is willing to sacrifice in order to get a model that suits its needs.

5 Conclusion

This paper set out to examine the relationship between the Business Concepts Model and the Business Rules Model. In order to test this relationship we used fictitious examples of Business Concepts Models and fictitious BRs. We changed the characteristics of the Business Concepts Models by ‘shrinking’ and ‘unshrinking’ them, essentially manipulating the terms and facts within them, and observing the effects on their corresponding BRs.

This paper sheds some light on the relationship between the Business Concepts Model and the Business Rules Model. We can show that the ‘shrunk’ or ‘un-shrunk’ state of the Business Concepts Model directly influences the common type expression of the Business Rules Model. Furthermore there are hints at an increase in complexity in BRs built on the ‘un-shrunk’ model while there is an apparent decrease in complexity in BRs built on the ‘shrunken’ model. It seems that complexity increases as the number of terms and many-to-

many participation facts between those terms increase. Generalization facts, while they add to the complexity of the Business Concepts Model, seem to have no impact on complexity in BRs at all. Complexity in natural language BR can lead to issues with managing BRs. The only apparent trade-off for using the shrunk model, yielding less complex BRs, is a loss of the ability to talk about certain concepts in the BRs. Nonetheless, the degrees to which BRs can be expressed in natural language remain uncompromised. When shaping the Business Concepts Model business needs are going to be factored in when deciding on what state of the model to deem acceptable.6

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