Business Rules Friendly or not so Business Rules Friendly Business Concepts Modelling - Early Experiences from a Business Rules Project on a Digital Vaccination Recommendation Service

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2010

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Abstract. WHO estimated in 2002 that 1.4 million children in the world would die from preventable diseases (World Health Organization, 2010). Each child is, or should be, immunized according to their national immunization schedule, which regulates i.e. vaccines and doses. Problems emerge when immigrant children should be transferred from one national vaccination schedule into another. This problem is quite evident in Sweden (Statistics Sweden, 2010). Vaccination practitioners have a hard time figuring out how to immunize an immigrant child. As a remedy for this situation, the VacSam project develops a Business Rules (BR) centric digital service through principles of (BR Approach), for providing unique vaccination recommendations. The service is designed using a commercial BRMS (BR Management Systems), which require a business concepts model. Thus, the paper presents early findings on how a business concepts model could be designed more or less BR-friendly. We have discovered, by designing, that a rigid, relational model approach is not BR-friendly. Instead, the concepts model should be designed to provide rule clarity and understandability. Thus, we draw the conclusion that a concepts model designed for persistent data storing, favouring a good quality relational model, is not rule friendly.

Key words: Business Rules, Business Rules Approach, Business Rules Management Systems, immunization, immunization schedules.

1 Introduction

The Business Rules Approach (BRA) is a rather new approach to Information Systems Development (ISD) focusing on one of the most important assets in business, namely business rules (BR).

The tenets of the Business Rules Approach (BRA) are: Separation of rules from other parts of the software; Traceability and versioning of rules; Rules written declarative in as natural language as possible; And, most importantly, that business rules should be managed by business experts and not IT (see e.g. Graham, 2006; Morgan, 2002; von Halle, 2002).

Many BR authors (e.g. (Bajec and Krisper, 2005; Graham, 2006; Morgan, 2002; Ross, 2003) stress the connection between the BR model and other parts of the business model: BR should for instance be consistent with the business concepts model and use the terms and facts defined in that. A business concepts model is normally designed for persistent data storage and implemented using a relational model logic favouring high degree of normalization and low redundancy, and avoiding null values. This can lead to a business concepts model that includes complex relationships, such as chains of associations, between entities or terms. This might affect how business rules can be formulated, since the possible complexities of the business concepts model will be mirrored in the business rules. If this is the case, the clarity, understandability, and changeability of the business rules might be compromised, making it harder for the business people to manage and maintain the implemented BR. If this is the case, the most important tenet of the BRA, i.e. that rules should be managed by business rather than IT experts, is jeopardized.

The research question we deal with in this paper is whether a business concepts model designed from scratch can be designed more or less BR-friendly. What will the important difference in rule clarity and understandability be if the business concepts model is designed from a rules authoring rather than persistent data storage perspective? To the best of our knowledge, this has not been studied before.

The tentative answer to the research question is based on early experiences of business concepts and business rules modelling in a research and development project called VacSam. The VacSam project will design and implement a Business Rules centric digital service, which will act as a child immunization diagnosis and recommendation tool for the health care sector in Sweden. Based on the world's immunization schedules transferred into automated rule sets and known facts about an immigrant child's immunization history, the service will provide explained vaccination recommendations that can be used for vaccine prescription (Carlsson, et al., 2008).

To design and implement the VacSam digital service, the project has chosen to use a commercial Business Rules Management System (BRMS). A BRMS provides the user/developer with tools for rule authoring, testing, deploying, and management. The particular BRMS we have chosen requires a domain specific vocabulary in the form of a business object model (BOM) in which terms and their relations are expressed. This BOM is generated from Java classes of the business concepts (a so-called XOM). The business rules designed and implemented in the BRMS incorporates the business concepts defined by the BOM and the BOM thus affects the rule formulation. Will it make any important difference if the BOM (and XOM) is designed from a BR perspective?

The remainder of this paper is structured as follows. The next chapter discuss the problem of immigration and child immunization, and describe the VacSam project and digital service. The third chapter explains Business Rules and design of these, the Business Rules Approach, and Business Rules Management Systems. The fourth chapter discuss early experiences from designing the VacSam digital service using a commercial BRMS and the difference between rule-friendly and not so rule-friendly business concepts modelling. We end the paper with our conclusions.

2 People mobility and immunization

In 2008 there were 120 000 children[1] born in another country but living in Sweden (Statistics Sweden, 2010). They have immigrated to Sweden with their parents as refugees seeking asylum, seeking better living conditions, or for other reasons. Also in 2008, 45 294 persons[2] emigrated from Sweden to return to old home countries or to move to other countries (The Immigrant Institute, 2009). Thus, there is a great movement of people to and from Sweden, and the situation is probably the same in many countries in the world.

Each country in the world has its national immunization schedule, in which vaccines and vaccination intervals are set. The various national infectious disease control organs, such as SMI[3] in Sweden, provide the schedules to WHO. WHO then publish them on the web for public access (also as a downloadable spreadsheet).[4]

Excerpts of this spreadsheet are shown in Figure 1 and Figure 2 depicting the national immunization schedules of Sweden and Finland. Even though these two countries share borders, have a long and common history and in many ways could be considered as quite similar, the schedules differs.

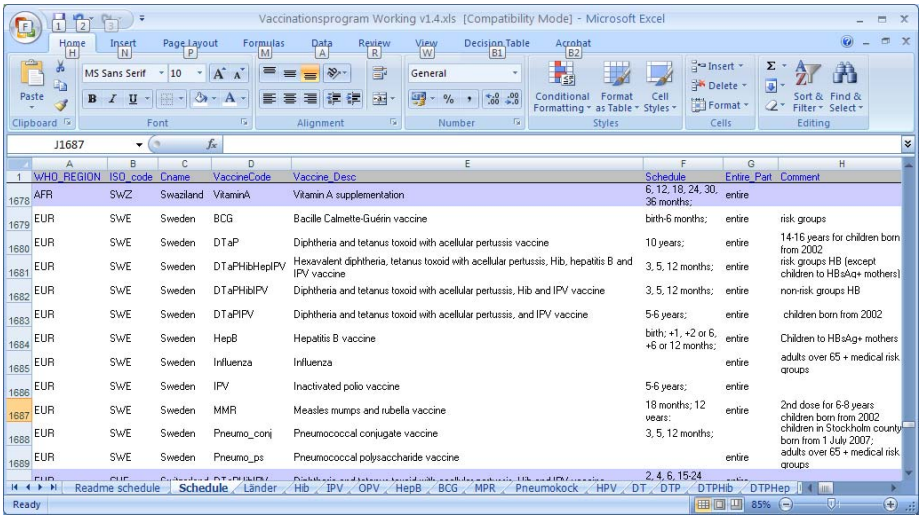

Figure 1: Excerpt showing Sweden in WHO's spreadsheet of all the vaccination schedules in the world

Sweden has 11 vaccines or combinations of vaccines in its schedule and Finland has 13. The differences in vaccines and vaccine combinations are:

1. Sweden has a hexavalent combination vaccine in DTaPHibHepBIPV, but in Finland HepB is a separate vaccine.
2. Sweden has Pneumo_conj vaccine. Finland does not.
3. Finland has HepA, MenACWY, Rotavirus, TBE, and Td vaccines, which Sweden does not have.

At closer look, more differences can be found in the schedule for some of the common vaccines of Sweden and Finland:

1. In Sweden DTaP is given to ten-year-old children. In Finland, the same vaccine is given to children between 14 and 15 years of age.

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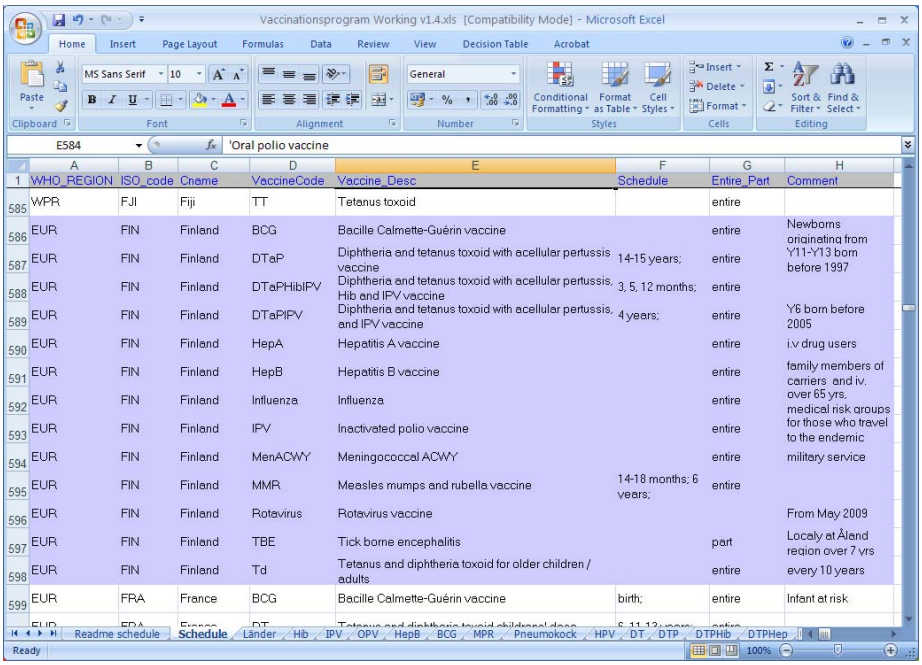
[1] A child here is a person in the age of between one and seventeen years
[2] Separate statistics for children is not available
[3] The Swedish Institute for Infectious Disease Control
[4] http://www.who.int/immunization_monitoring/en/globalsummary/ScheduleResult.cfm There almost two thousand rows of vaccines and vaccine combinations in the spreadsheet.

2. In Sweden MMR is given to children in two doses: dose one at 18 months of age and dose two at 12 years of age. In Finland, dose one is given at 14-18 months of age and dose two at six years of age.

Even more differences are found if also the Comment column is considered.



	A	B	C	D	E	F	G	H
1	WHO_REGION	ISO_code	Cname	VaccineCode	Vaccine_Desc	Schedule	Entire_Part	Comment
585	WPR	FJI	Fiji	TT	Tetanus toxoid		entire	
586	EUR	FIN	Finland	BCG	Bacille Calmette-Guérin vaccine		entire	Newborns originating from Y11-Y13 born before 1997
587	EUR	FIN	Finland	DTaP	Diphtheria and tetanus toxoid with acellular pertussis vaccine	14-15 years;	entire	
588	EUR	FIN	Finland	DTaPHibIPV	Diphtheria and tetanus toxoid with acellular pertussis, Hib and IPV vaccine	3, 5, 12 months;	entire	
589	EUR	FIN	Finland	DTaPIPV	Diphtheria and tetanus toxoid with acellular pertussis, and IPV vaccine	4 years;	entire	Y6 born before 2005
590	EUR	FIN	Finland	HepA	Hepatitis A vaccine		entire	i.v drug users
591	EUR	FIN	Finland	HepB	Hepatitis B vaccine		entire	family members of carriers and iv.
592	EUR	FIN	Finland	Influenza	Influenza		entire	over 65 yrs, medical risk groups
593	EUR	FIN	Finland	IPV	Inactivated polio vaccine		entire	for those who travel to the endemic
594	EUR	FIN	Finland	MenACWY	Meningococcal ACWY		entire	military service
595	EUR	FIN	Finland	MMR	Measles mumps and rubella vaccine	14-18 months; 6 years;	entire	
596	EUR	FIN	Finland	Rotavirus	Rotavirus vaccine			From May 2009
597	EUR	FIN	Finland	TBE	Tick borne encephalitis		part	Localy at Åland region over 7 yrs
598	EUR	FIN	Finland	Td	Tetanus and diphtheria toxoid for older children / adults		entire	every 10 years
599	EUR	FRA	France	BCG	Bacille Calmette-Guérin vaccine	birth;	entire	Infant at risk

Figure 2: Excerpt showing Finland in WHO's spreadsheet of all the vaccination schedules in the world

Schedule differences between Sweden and other countries are numerous and detailed. Thus, when an immigrant child of a certain age should be immunized according to the Swedish schedule, the Swedish healthcare sector face two determining questions:

1. What vaccines does the child lack according to the Swedish schedule?
2. What vaccines should the child have been given according to the schedule of the country the child came from?

To answer these questions medical practitioners must thoroughly know the Swedish schedule and the schedule of the child's previous country. They must also know the immunization history of the child. These requirements seems however hard to meet.

The effect of this is over use of vaccines. Immunization experts in the VacSam project informally estimate that 70% to 80% of all vaccinations in Sweden are unnecessary[5]. This results in unnecessary suffering for children with increased risks of contraindications and allergic reactions, and a waste of taxpayers' money and medical resources. What is needed is a help for the medical practice to avoid over use of vaccines and increase the quality and control of immunizations in Sweden. The VacSam service will be this help.

2.1 The VacSam Research and Development Project

In 2008 people at the Department of Informatics at LUSEM, The Swedish Institute for Infectious Disease Control, and IDS Scheer Sweden joined forces to apply for project funding from The Swedish Governmental Agency for Innovation Systems (VINNOVA) in the call *Innovativa användare i en samverkande e-förvaltning (Innovative users in a cooperating eGovernement) (Carlsson, et al., 2008).* The project application was accepted and VINNOVA is funding 50% of

[5] According to medical professionals, the pinpricks should be kept to a minimum.

the total project budget of 3.4 MSek. The project duration is 2008.11-2011.11, but it started in practice in February 2009.

The VacSam project has two goals:

1. To develop a Business Rules oriented digital service that can provide help to medical practitioners to better assess a child's need for immunization and transfer that child into the Swedish national immunization schedule. The service will give an immunization recommendation for any individual child, based on known facts of the child's immunization history and rules based on regulations and schedules. The rule sets will be run as a service in a Business Rules Management System (BRMS).
2. To research how rule based, digital services can be designed inter-organizationally for cooperating, rule intensive governments. The VacSam-project research is positioned within Service Science from a business perspective and is carried out as Design Science. The research outcome will be research papers and a dissertation providing an approach for a business driven SOA-initiative through Business Rules Approach.

The immunization practice is, as have been shown above, highly regulated through the various schedules, which suggest to use the Business Rules Approach. Another consideration is that it is important that the rules governing the immunization process belong to the practice and not the IT department, so that changes in regulation (especially the schedules) can be made by designated practitioners who are business experts, rather than experts of IT. This is one of the cornerstones of the Business Rules Approach.

Even if the rules in the form of immunization schedules and other vaccination regulations are not very volatile or in constant flux, the point of a business rules oriented digital service is still strong. The immunization practice is a business where exact and uniform operations and explicit conformance to regulations are vital. The problem is that these requirements are presently not fulfilled.

3 Business Rules

Business Rules should be based upon facts; in turn, facts should be based upon concepts that are represented by terms. By motivating the Business Rules through important aspects of the business, BR can affect the behaviour of the organization in a desired direction (Ross, 2003). BR should be available for defendant personnel and have only one source through the BR repository. The rules should also be specified by defendant personnel and they have to be manageable (Ross, 2003). Morgan (2002) presents a definition of a Business Rule as:

> […] the conditions under which a process is carried out or the new conditions that will exist after a process has been completed. (Morgan, 2002, p. 59).

A BR can be interpreted as a claim which defines or delineates an aspect of a business (van Eijndhoven, et al., 2008). The Business Rules Approach derives from three traditions; the Data Base tradition, the Unified Modelling Language tradition (UML) and, the oldest tradition, Artificial Intelligence (AI) (Graham, 2006). As BR originates from three different traditions, there are several different types of Business Rules. Morgan (2002) categorizes them into three different categories: *Definition Rules* which are able to provide a definition to a term or to show qualitative and quantitative relations among terms.

As the complexity of relations between terms increase, the problem should be divided into smaller pieces. This advocates the use of rule sets. In connection with definitional rules rule sets can be used to find business activities and also indicate organizational directions (Morgan, 2002). However there is another increment in what Morgan (2002) defines as definitional rules. These are presented as *External Rules* by Bajec and Krisper (2005) which are rules that come from i.e. environment analysis and can be derived from an organization's surroundings (Ibid.).

The next type of rules are the *Behavioral Rules*, they define actions for specific situations and 'what' to be done (Morgan, 2002). The third types of rules are the *Structural Business Rules* which describes delimitations or relations between parts of a system (Morgan, 2002).

However, there are rules that do not comply to any of the above stated. This might be a result of the futility in classifying rules.

BR could also be seen as statements which can influence or guide the behaviour of information, thus bridging the gap between data and organization (Steinke and Nickolette, 2003). Four types of BR provide this perspective (Steinke and Nickolette, 2003): *Definition Rules* which defines entities and attributes, *Fact Rules* that represents the relation between entities and their belonging attributes. *Constrained Rules* presents terms for data and the *Derivation Rules*, which often uses logic in the creation of new information.

That BRA strengthens the relations between the business goals and visions, the implemented BR and the anchorage of the Business Rules in the *Enterprise Model* (EM) (Bajec and Krisper, 2005; Object Management Group, 2008a; Rosca, et al., 2002)is based upon the positioning of the BR in the EM (Bajec and Krisper, 2005). Through this position, BR is integrated in EM that in turn could be used for creating abstractions of an organization. The aim is to construe a notion of whether the organization works in a declarative manner or not, but also how its business is run and how it is structured (Bajec and Krisper, 2005).

3.1 The Business Rules Approach

Business Rules Approach or BRA is a systems development approach, which accommodates the key entities of the business rules (BR) movement. BRA is neither the latest nor the best system-development methodology. It does not replace the requirement analysis but is not just another set of tools (von Halle, 1997). BRA has the quality of isolating the effects, which are brought by changing business logic. Also, when a change occur, the approach leads to that the business is only affected to a controllable extent (Thi Anh-Duong and Thanh Binh, 2009)

BRA has developed through Information Systems Science from both the professional and the academic domain. Fronting the movement is among others: Morgan (2002), von Halle (2002) and Graham (2006). BRA advocates the usage of the core components of what can be found as the BR-paradigm, including that Business Rules are expressed in 'natural language' that can be executed by an Information System (IS).

The basic principles of BRA accommodates that Business Rules (BR) always should be explicitly expressed in a natural language. Also, BR should exist independent from workflows and procedures (Ross, 2003). BRA is an approach that holds the power of resetting the influence of the business logic/BR from the 'IT Department' to the defendant business personnel. The 'IT Department' though should still be responsible for the technicalities corresponding to the implementation of the Business Rules Management System or other technicalities associated with BRA (Graham, 2006; Morgan, 2002).

BRA includes Business Rules design that excludes expressions corresponding to 'how' the rule is executed, 'where' the rule is executed, 'who' is responsible for the rule execution and 'when' the rule is executed. The key stakeholder 'BR', within BRA, should not be designed describing 'how', 'where', 'who' or 'when'. An example could be stated as: *A society has to include both members and non-members*. This rule does not state 'how', 'where', 'who' or 'when' and is therefore accepted. It is also presented in a declarative manner (Ross, 2003).

The BR management should be executed as an independent discipline of systems and business development within a BRA (von Halle, 2002). The discipline could thus advocate clarification of the BR. The application of BRA could in turn lead to that, the BR will be implemented as well-formed.

Dedicated techniques such as *Business Rules Management System* (BRMS), *Business Rules Engine* (BRE) and *BR repository* are other key components within BRA. The application of them leads to a separation of BR from application specific code (Bajec and Krisper, 2005; Gra-

ham, 2006), where application specific code could be interpreted as i.e. SOA realizing technology i.e. Web Service. Linehan and Ferguson (2005) presents that SOA and BR shares service oriented concepts. BRE is an example of the service-oriented concepts, which is shared between BRA and SOA where BRE could be provided as a Service by providing business logic in a service-oriented manner.

BR repository enables the use of BR management, with accompanying documentation, as a strategic resource (Ceponis and Vasilecas, 2006; Morgan, 2002). This is because the BR repository enables the quality, versioning, traceability, and responsibility control of the Business Rules. Business Rules Engine (BRE) provides an automated rule application of rule set(s) and rule flow(s) on which inference such as backward and forward chaining is enabled.

Illustrated in Figure 4 is the BR model supporting the visions of a business.BRA strengthens thus the relations between the business goals and visions, the implemented BR and the anchorage of the Business Rules in the *Enterprise Model* (EM) (Bajec and Krisper, 2005; Object Management Group, 2008a; Rosca, et al., 2002).

The EM (Figure 3) accommodates five sub-models according to Bajec and Krisper (2005): The *"Business Vision Model"* presents the overall strategy of the organization focusing on goal structure and on the problems standing in its way. The *"Business Process Model"* describes the necessary process for being able to achieve the described structure of the goals and how the process explains its input and output. The *"Business Rule Model"* defines and maintains the explicit BR, likewise the implicit ones which comes from other models. The *"Resource and Actors model"* focuses on the structure of the resources and their relation to actors, likewise with the goals and the other components of the EM. The *"Concepts model"* establishes a common vocabulary for all the concepts that touches upon the organization. It aims to minimize miss conceptions of the ontology within the organization (Bajec and Krisper, 2005).

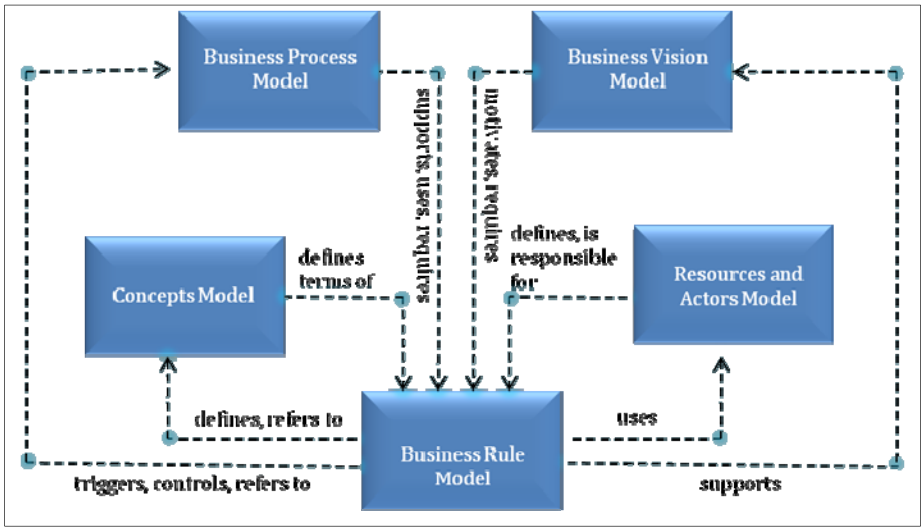


Figure 3: The Enterprise Model (Bajec and Krisper, 2005, p. 428)

BRA provides thus adaptability by advocating the separation of business logic from the Business Process when implemented in Business Rules Management Systems. Alliances could therefore be explicitly modified to accommodate context-specific situations within activities. By this a higher level of agility within the business processes is achieved (Thi Anh-Duong and Thanh Binh, 2009)

The basic principles of BRA include authoring of Business Rules as explicit (Ross, 2003). BRA advocates the application of the core components of the BR paradigm, presented below.

3.2 Business Rules Management System

There are several reasons for adopting Business Rules Management System (BRMS). Business drivers such as reuse of legacy IS and centralized business policy management is one example. The personal service and information exchange is another (Graham, 2006). BRMS accommodates different components. Business Rules Engine (BRE) is one of them. BRE provides the functionality of inference which is used for drawing conclusions (Graham, 2006) BRMS therefore provides automated inference supporting BR. BR repository is another component accommodated within a BRMS. BR repository presents knowledge for data through BRE (Graham, 2006).

Strategies of inference are 'forward chaining' and 'backward chaining'. Backward chaining is goal driven and could be used for i.e. diagnosing or making a choice. Thus derives forward chaining the goal from fact. Forward chaining or data direct inference means that BR is applied on all available data and by that tries to discover as much as possible (Graham, 2006). A typical application of forward chining is within process control and scheduling (Graham, 2006).

As BR within BRMS is categorized as non-procedural they express *what* is true and not *how* it should be calculated (Date, 2000). However the separation of applications specific code and BR is eased by the application of the BR repository (Graham, 2006). Business owners are able to modify and manage the BR via BRMS. Thus, focus on the BR management. The management of BR is provided when the BRMS provides a complete BR repository and supports backward chaining. Likewise BRE should be able to provide itself as a service for use in greater contexts (Graham, 2006). Such a context could be a service, which is used by an external ERP system, which advocates the component distribution of the BRMS as suitable for a SOA. Figure 4 illustrates an example of how BRE provides the rule sets as a Service by describing the web service description language (WSDL) definition:

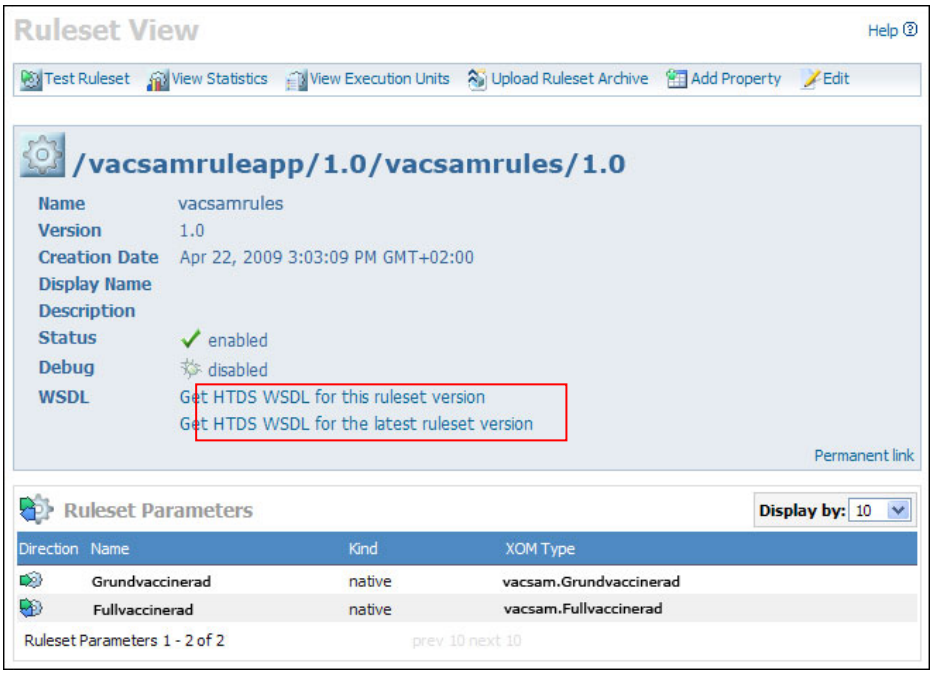


Figure 4: The web interface to Ilog Rules Execution Server

The BRMS is also responsible for providing reporting tools and compatibility with SOA by providing functionality for this. It should also, from a product specific point of view, be regulated by commercial standards where professional support is available according to Graham (2006).

3.3 Business Rules Design and Development

There are three types of architectures, which can be described as technical architecture, component architecture and business architecture. Common for all of the three is that they can be used in separating *what* from *how* by using the accommodated models. The aim is to achieve an agile business and a technical independence. The models can be expressed notationally in i.e. UML (Morgan, 2002) and the expression of BR can be made on different levels: natural language, technical language, and formal language. BR holds a structure but allocates different parts of the meaning with the business and the desired business properties (Morgan, 2002).

For being able to achieve the highest grade of structure, the most formal level of expression would be to consider. However this would probably lead to a hard time for business personnel figuring out what the BR means (Morgan, 2002). According to the BR manifesto:

> Rules should be expressed declaratively in natural language sentences for the business audience (Article 4. Declarative, Not Procedural, 4.1).

The condensed explanation of how to develop BR is by analyzing the business. Most BR could probably be found by performing a business analysis. The focus would be on the business plan in this phase. The BR adds the ground for the vocabulary, which is derived from BR. The vocabulary in turn should be expressed in notational form such as SBVR, which could be transformed into i.e. UML. The vocabulary illustrates the relationships between terms in the ontology of the context and thereby provides the Business Object Model (BOM).

The BOM could be exemplified by: **Child** *is a* **Person**, **Foreign Child** *is a* **Person**.
The UML notation presented in Figure 5 is:

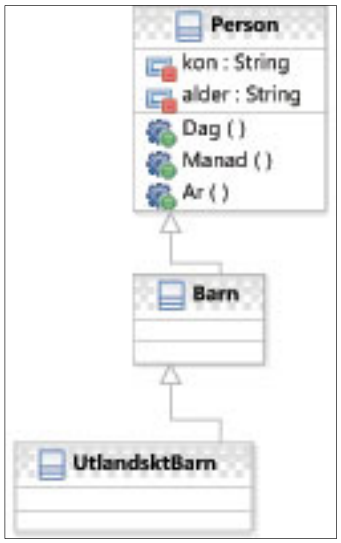


Figure 5: A fragment of the UML model for the VacSam digital service

The vocabulary and the UML are derived from BR, which originates from the business plan (i.e. SOSFS-*) and looks like:

BR 1. A person is defined as a child if all of the following conditions are true:

a. the person is new born
b. the person is at most 18 years old

BR 2. A child is defined as a foreign child if the child comes from another country than Sweden.

However, according to the different level of expressions presented by Morgan (2002), BRMS product specific properties limit the natural language. Thus, the products are, more or less, linguistic.

4 Designing the BR Centric VacSam Service

Since the VacSam project will deliver a rule-centric digital service, we will use a BRMS for design, test, and delivery of the service. A full-fledged, commercial BRMS from the big vendors such as Oracle (Haley), FICO (Blaze Advisor) or IBM (Websphere Ilog JRules) can cost several hundreds of thousands of dollars per license, which is way beyond the reach for the VacSam project.

We have looked at Open Source or free-ware alternatives like Drools or Jess, but they seem to be more suited for developers than for business experts. They also lack good BR management capabilities, like the very important BR repository, and are still immature when it comes to natural language rule authoring.

Luckily for us, IBM bought the French firm Ilog and thus their BRMS products in 2009. Through the IBM Academic Initiative, we now have non-limited access to the Ilog JRules BRMS, which we will use to design and implement the decision service.

We have followed the advices given in Morgan (2002), Graham (2006), and Kardasis and Loucopoulos (2005) about where to look for business rules. We have performed what Morgan (2002) call static analysis, i.e. gone through and analysed documentation in the form of regulations published by The National Board of Health and Welfare (Socialstyrelsen, 2008), policies and guidelines from Region Västra Götaland and Stockholms läns landsting[6], the WHO schedules spreadsheet (World Health Organization, 2010), and reports on immunization in Sweden from SMI.

Based on these texts and documents we have designed business rules in natural Swedish, according to the guide lines on rules formulation found in Morgan (2002) and Ross (2003). The first 50 rules we designed were quality checked in a workshop with one of the immunization experts in the project. Apart from a few added and corrected rules, the rules we had designed were of proper quality. We therefore continued our rule design work and presently we have formulated 2340 business rules covering the world's all immunization schedules found in WHO's spreadsheet. The business rules are written using standard word processing software. The first three rules are shown in Figure 6 (translated from Swedish).

RS-1. A person is defined as a child if all of the following conditions are true:
- a. The person is a new born
- b. The person is at most 18 years old

RS-2. A child is defined as a foreign child if the child is from another country than Sweden

RS-3. A child is basic vaccinated according to the Swedish vaccination schedule if all of the follwing conditions are true:
- a. The child has been given dose 1 of Diphteria vaccine
- b. The child has been given dose 1 of Tetanus vaccine
- c. The child is a foreign child
- d. The child is not fully vaccinated according to the Swedish vaccination schedule

Figure 6: The first three business rules

Based on the collection of business rules, we designed a business vocabulary model in SBVR style (Object Management Group, 2008b) for the rule service. A model of the business vocabu-

[6] The two largest country councils in Sweden.

lary is necessary, since business rules execute on business data and these models should be consistent with each other (Bajec and Krisper, 2005; Graham, 2006; Morgan, 2002; Valatkaite and Vasilecas, 2005; von Halle, 2002).

We transferred the SBVR business concepts model into a UML class diagram using Rational Software Architect 7.5.5 for later UML to Java automatic transformation. The first business concepts model in UML we designed based on what we have been taught in our education: a well-formed conceptual model that can be transformed into a relational model in at least third normal form without redundancy and null values. The first UML model is shown in Figure 7.

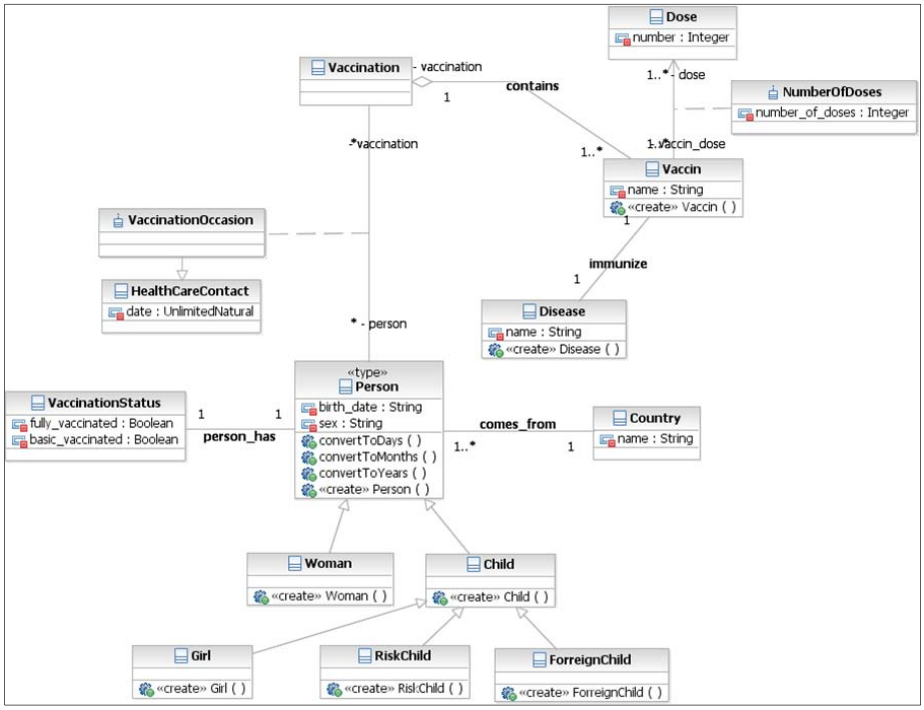


Figure 7: The first conceptual model

In the Ilog JRules BRMS you have to have a BOM (Business Object Model) for the business concepts in the rules. This BOM is generated from a XOM (eXecutable Object Model) of compiled Java classes of your business concepts. We used Rational Software Architect's transformation tool to generate Java classes from our UML model. These classes were then compiled to become the XOM. The BOM is then verbalized so that the members and methods are presented as more natural language-like statements to be used in the rules formulation[7].

We tested how to write and run rules in the Ilog JRules BRMS using the three business rules in Figure and ended up with the implemented set of rules in Figure 8.

These rules do work, but they look complicated and are less easily understandable than we wanted and the Business Rules Approach recommend. How could these rules be understood, let alone be managed by practitioners? For sure, they are probably much easier to understand than a number of methods of Java code would be, but still not easy enough.

What makes the rule set complicated is actually the business concepts model. In it, there are a number of associations, which lead to collections in the Java code. That is why the rules include lines such as "… at least one vaccination in the vaccinations of 'person' where the vaccines in this vaccination contain 'vaccine 1'". The Person object holds a collection of Vaccination objects, which holds a collection of Vaccine objects, which holds collections of Dose and Disease objects.

[7] Instead of e.g. Person.convertToYears() the verbalization will provide the more natural language sentence the age in years of the person.

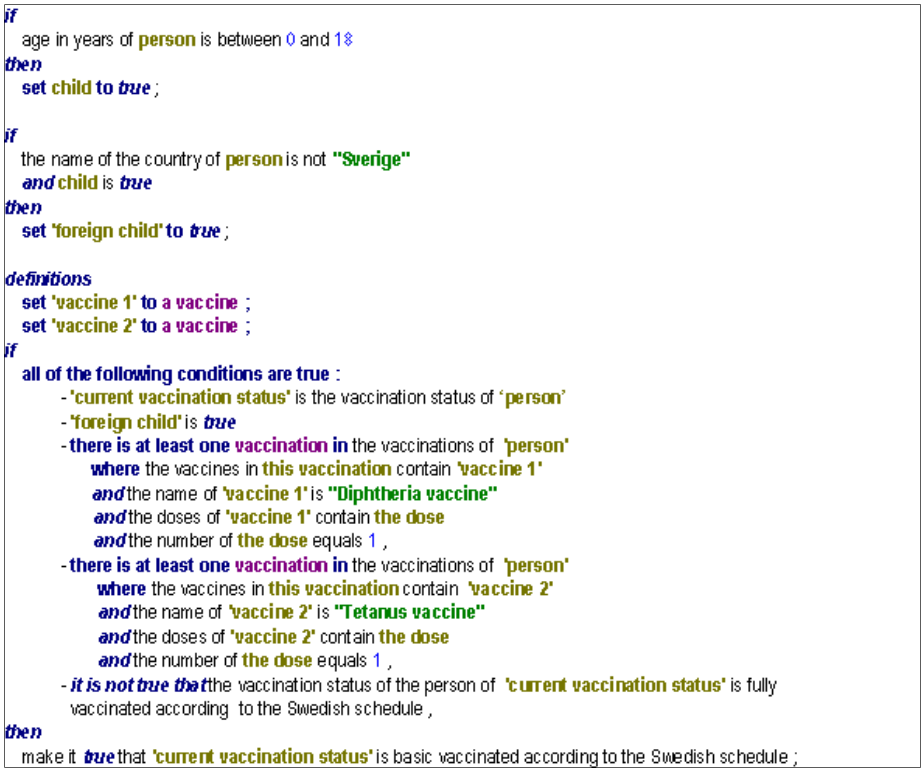


Figure 8: The first set of rules in Ilog JRules

After much thinking, we decided to focus on redesigning the business concepts model to better suit simpler and more understandable rules. The business concepts model was after all not intended for designing a persistent data layer. Thus, the issues of normalization, redundancy, and null values have less bearing on the problem, as long as the concepts are the same as the types in the UML model (Person is still Person).

Based on this understanding we designed a new UML model and concentrated on the types necessary for the three business rules (Figure 9).

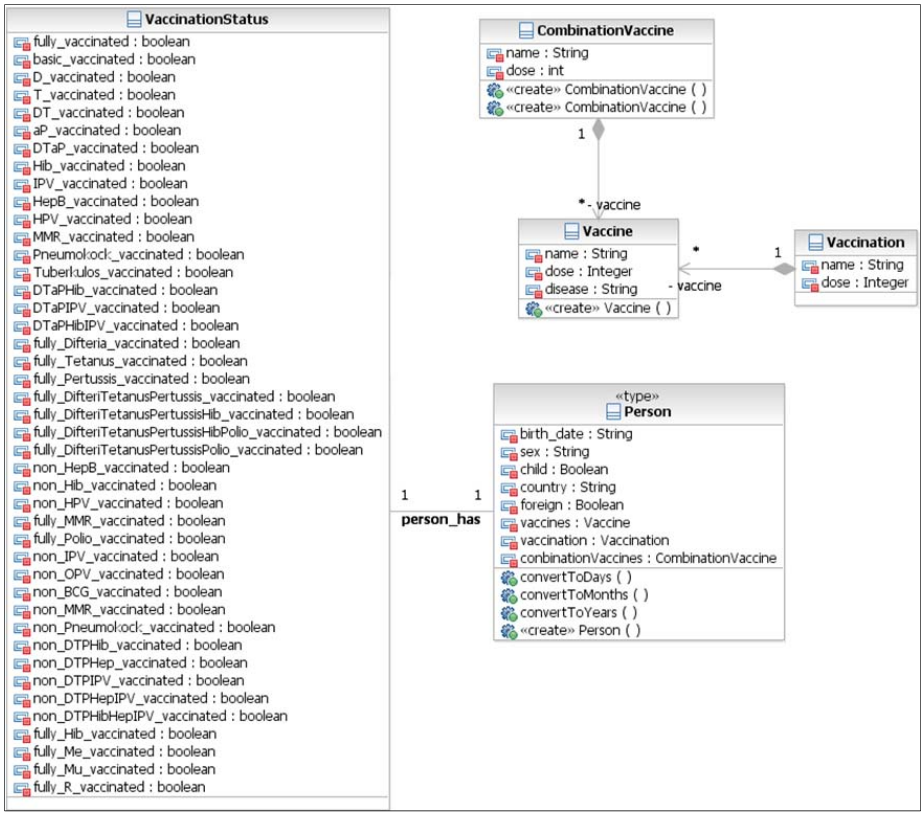


Figure 9: The second conceptual model

The new BOM made it possible for us to formulate the three business rules as implemented rules in Figure 10.

```
if
   the age in years of the person is between 0 and 18
then
   make it true that the person is a child ;

if
   the country of the person is not "Sweden"
then
   make it true that the person is foreign ;

if
   all of the following conditions are true :
         - 'vaccination status' is the vaccination status of the person
         - the person is a child
         - the person is foreign
         - there is at least one vaccine in the vaccines of the person
              where the name of this vaccine is "Diphteria vaccine"
              and the dose number of this vaccine is 1 ,
         - there is at least one vaccine in the vaccines of the person
              where the name of this vaccine is "Tetanus vaccine"
              and the dose number of this vaccine is 1 ,
         - it is not true that the vaccination status of the person is fully vaccinated according to the Swedish schedule
then
   make it true that the vaccination status of the person is basic vaccinated according to the Swedish schedule ;
```

Figure 10: The second set of rules in Ilog JRules

Compared to the rules in Figure these rules are more compact, less verbose, more natural language-like, and easier to understand and change. We argue that this is the result of changing the business concepts model to better suite rules formulations instead of persistent data storing.

Many of the authors on BR referenced in this text stress the importance of consistency between different models in EM and that BR must operate on the business concepts used in the

rest of the business. However, to the best of our knowledge, we have not found any discussion of trade-offs between a well-formed (from a relational model point of view) business concepts model and rule clarity and understanding. It seems to us that as long as you use the same terms (e.g. Person), but apart from that strive for a bespoke concepts model for the BR model the easier it will be to fulfil the promises of easily understandable and manageable automated rules.

5 Conclusions

This paper presents some experiences of designing and developing a BR oriented digital service for immunization recommendations for immigrant children in Sweden.

In the project we have designed 2340 BR based on schedules and regulations from The National Board of Health and Welfare (Socialstyrelsen, 2008) and policies from other sources.

What we have discovered so far, is that a business concepts model or vocabulary designed for persistent data storing, favouring a good quality relational model, is not rule friendly. Instead, the business concepts model should be designed to accommodate better rules as long as the model keeps with the central terms. To the best of our knowledge no author, even if they stress the importance of consistency between BR and business concepts, discuss the consequences of a rigid approach to business concepts modelling for BR.

Acknowledgment

The VacSam project is sponsored by VINNOVA.

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