Building flexible eHealth processes using business rules

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Abstract: This article describes how business agility in a health insurance company can benefit from more flexible business processes. The suggested architecture for a flexible information system is service-oriented and uses a business rule management system to externalize rules. At the organizational level the business rule approach helps to identify and formalize rules.

Introduction

This paper focuses on business process optimization in healthcare. Today, information systems (IS) are widely used in healthcare organizations. Some examples are:

- electronic medical records that enable easy communication of patient data between different healthcare professionals,

- telemedicine which is the delivery of medicine at a distance,

- systems with information about drugs,

- or healthcare business process management (BPM), which automates workflows of administrative processes.

In the following sections we will concentrate on healthcare business management systems where business processes are modeled and executed. These workflow or business process management systems are often used in health insurance companies.

We will take two views in this article, the business and the technical view.

The questions we will address in the business view of the article are:

- What does eHealth in the health insurance industry have to do with process improvement?

- What are business rules and why are they important for business agility?

In the technical section we will address the following questions:

- Where do business rules reside in traditional information systems?

- What architecture is enabling eHealth information systems in the insurance industry to be adapted rapidly to the changing political, judicial, and business environment?

Finally we will present a short case study to verify the theoretical insights with a practical example. The business case focuses on claims processing and fraud detection in a major private health insurance company.

Business View: eHealth and Process Improvement

The term eHealth emerged around the year 2000 (cf. [Pa05]). Oh et al. [Oh05] analyzed various definitions of this term. For the purpose of this article we retain one of the early definitions:

"e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology." [Ey01]

The health industry has a wide variety of actors. An important group of organizations are health insurances. The health insurance industry has been changing rapidly over the last years throughout Europe. In many countries we observed a liberalization of the market. The last years have also been marked by a proliferation of internet technologies. At the same time, the industry is highly regulated by laws. Health insurance companies have to adapt constantly to this changing environment.

However, traditional information systems are often rigid. Business-driven requirements for modifications in business processes are difficult to implement in the information systems without programming new code. As a result, business has to adapt to the capabilities of its information system and not vice versa.

One of the objectives of information systems in health insurances is to increase business agility, i.e. be able to react more rapidly to changes in the business environment. To support this objective, the information systems have to be flexible.

Business process improvement is the constant search for optimizations in an organization [DS90; Ha91]. Such improvements can be the introduction of ICT to support or automate certain activities.

An activity that is traditionally time consuming in health insurances is the manual inspection of claims. The clerks check claims according to certain rules. These rules define which claims are valid and which claims may be fraudulent. The automation or support of such tasks can lead to faster and more efficient business processes. The challenge of automating activities is to formalize decision rules and embed these rules in a business process management system.

We see information systems that help to improve business processes in healthcare as one important aspect of eHealth.

Business View: Business Rules

What is a business rule?

Business rules exist in every organization. According to the Business Rules Group a business rule is: "[A] statement that defines or constrains some aspect of the business ... [which is] intended to assert business structure or to control or influence the behavior of the business." [BRG00]

Business rules are stated in many different ways but always use natural language (cf. [Ro97]). They can be stated in business procedure manuals, where they are often declared in terms of business policies. They can be stated in government regulations and manuals (cf. [Ch95]). They can be stated in business contracts where they are represented by the terms and conditions of the contract. They can be stated in service level agreements. They can be 'common knowledge' among the business executives, management, and staff. In some cases, business rules are already formalized in decision tables or decision trees, which can lead to a more compact and structured representation and typically provide an excellent overview.

If
    Document Type is : Prescription
    and Physician Category is in (: GeneralPractitioner , : Internist , : <enter a value> [...])
    and Total Amount in : EUR is less than : 60 [±]

    GeneralPractitioner
    Internist
    Otologist
    Dentist
    Cardiologist
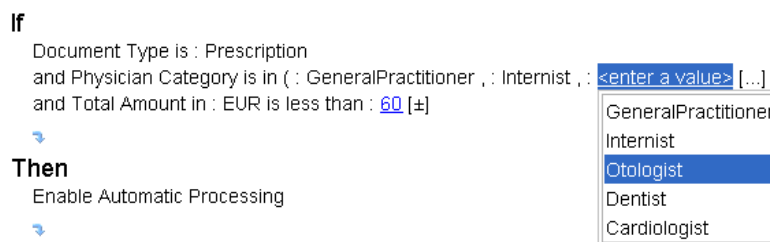
Then
    Enable Automatic Processing

Figure 1: Business rule in natural language

Figure 1 shows a typical example of a business rule from a claims processing application. It models the decision whether a claim document will be processed manually or automatically.

Rules are seldom defined explicitly and centrally. They are disseminated throughout the company. The business rules approach described later is a methodology to capture and manage business rules (cf. [BRP05]).

Regardless of the source of business rules, little attention is given to the enforcement of those rules (cf. [Ca05]). A market study in Switzerland revealed major reasons for the lacking enforcement of rules: employees do not know all the rules, rules change too rapidly, and there is often a misinterpretation of rules (cf. [BRP05]).

Once rules are documented they should be linked to the right business processes and enforced automatically by information systems.

Business Rules and Business Agility

The political, judicial, economic, environmental and cultural environment of organizations keeps changing. If a company wants to adapt to a changing environment, it has to adapt its strategies, business processes, organizational structure, products etc. This is a challenge for an organization as a whole. Agile organizations adapt more rapidly than rigid ones which can lead to competitive advantages (cf. [Po85]).

In the context of a health insurance the following factors can influence business rules:

- new diseases,

- new or modified laws on the health insurance market,

- modification in the legal basis for calculating insurance premium,

- new insurance products,

- marketing campaigns,

- new business model.

As a result, business rules are constantly changing in an agile company. Most of these changes have an impact on the information systems that support the business (cf. [Mo02]).

Technical View: Information systems and Business Rules

In this chapter we will analyze where business rules reside in traditional information systems. Then we will describe the business rules approach and the resulting architecture which enables information systems in the insurance industry to be adapted rapidly to the changing business environment.

Traditional approach

Traditionally, business rules reside inside the program code. They are usually implemented with "if … then …" statements. The rules are spread all over the information system. As seen above, business rules tend to change frequently. Typically, business rules change more frequently than the functionality of an information system (cf. [Ro03]).

If the business wants to change threshold level in our example from Figure 1 from 60 to 50 €, they expect this minor change to be productive in no time.

However, if rules are hard coded into the application, modifications of rules cannot be done by the same people who usually manage them, i.e. the process owners or business analysts. Any change in a rule has to be implemented by IT specialists. The changed code has to run through several stages before it can be deployed on a productive environment. This makes changes difficult and time-consuming.

Workflow / business process approach

Business process management or workflow tools go one step further. Workflow at its simplest is the movement of documents and/or tasks through a work process. Business process management encompasses the analysis, the modeling, the implementation, simulation, execution, monitoring and improvement of processes (cf. [WFM06; Pe03]).

Business process oriented information systems are executing tasks in the sequence defined in advance with conditions at certain branch points. A condition – i.e. a business rule – can be modeled in process tools. Decision steps can be defined in a process in a declarative way.

In our example, the rule would be one step or activity in the business process. A business analyst or any power user can now use the process management tool to modify thresholds or add new rules.

This process orientation has been an important improvement in the design of information systems. The flexibility of the system can be increased and business needs can be implemented faster.

However, the management of rules remains a problem with business process management systems. The business rules are still spread over several systems and it is difficult to ensure consistency. Furthermore, the definition and enforcement of the rules are not standardized.

Business rule approach and service-oriented architecture

The business rule approach is a development methodology where rules are in a form that is used by but not embedded in business process management systems (cf. [Ro03; BRC05]).

The business rule approach formalizes an enterprise's critical business rules in a language which managers and technologists understand. Business rules create an unambiguous statement of what a business does with information to decide a proposition. The formal specification becomes information for process and rules engines to run [Wi06]. An emerging standard for defining rules in a platform- and program-independent way is the Rule Markup Language (RuleML) [RMI06].

Modern information systems are designed and implemented according to a service-oriented architecture (SOA) (cf. [PN02; Ch04]).

SOA is a component model that inter-relates an application's different functional units, called services, through well-defined interfaces and contracts between these services [Jo05]. In a service-oriented business process management system, activities of a process are implemented by services. In this architecture, decision steps with business rules are services in a process. When these services are called by the process they will return the result of business rule evaluations. The rules are executed by a rule engine [Ge06].
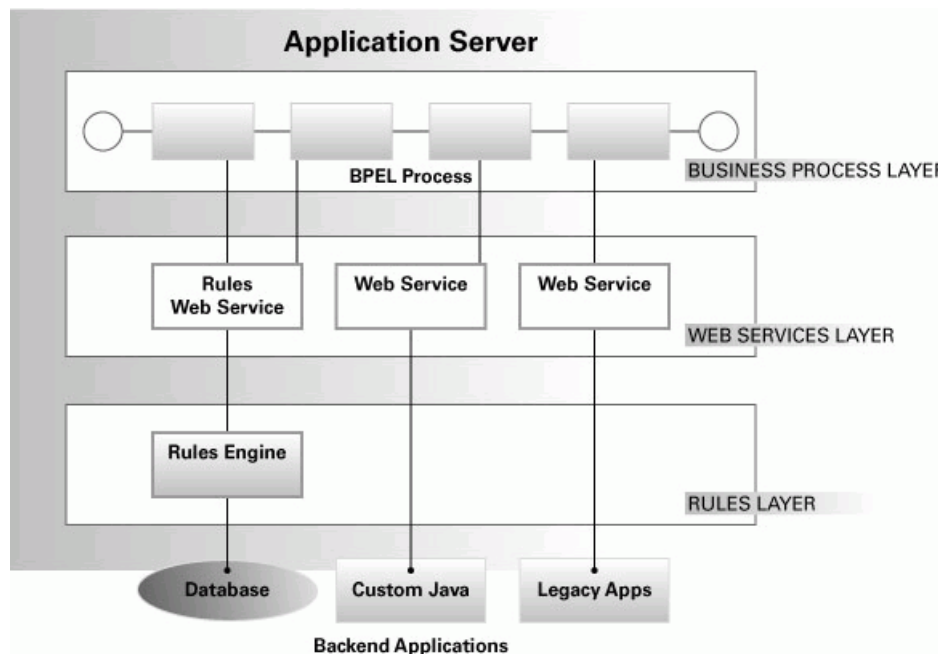

Figure 2: Architecture: separating rules from business process [Ge06]

Figure 2 shows the architecture of a service-oriented information system. Several layers are distinguished: business process layer, (web) service layer, rules layer. Other underlying layers are application and resource layers.

This architecture is loosely coupled. Business processes are handled by a process engine. The OASIS Standard Business Process Execution Language (WSBPEL) [OAS05] allows web service composition in process engines. Changes in the process can be made through a process designer.

One of many reusable services in a SOA is a rule service which implements a scalable rule execution environment. A vendor neutral implementation can be achieved by using the JSR 94 standard rule engine API [JSR04]. Business rule management systems offer the additional functionality to capture, organize and maintain the rules in a central repository (see next chapter).

The adoption of business rules adds another tier to systems that automate business processes. Compared to traditional systems, this approach has the following major advantages:

- rules are externalized and easily shared among multiple applications,

- the cost incurred in the modification of business logic is lowered,

- development time is shortened.

Through the use of business rules approach, the business agility is enhanced. And the manageability of business processes also increases as rules become more accessible.

Business rules management systems (BRMS)

Once business rules are captured and expressed, concerns turn toward verifying the consistency of rules and managing and enforcing them. This is especially critical as initiatives scale up towards larger numbers of rules (cf. [BRC05]).

We will use the term "Business Rule Management System" (BRMS) for a software system that helps managing business rules in a central rule repository (persistent storage and management part) and executes extracted rulesets in a dedicated rule engine (runtime part).

IT and business people are involved in setting up a BRMS. Ilkaev et al. (cf. [IM06]) describe the activities, roles and artifacts that are involved in the software development process and show how they are represented in the Rational Unified Process [Ra01]. The role of IT is to integrate the rule engine into existing applications and to implement the executable object model. The rule editing environment and rule repository are setup in a separate step, where the business vocabulary for rule definition is built on top of the object model.

BRMS can display rules in user-friendly forms such as decision tables and decision trees. Provided with a suitable interface to design and edit rules, it is possible for business users to check or change rules directly with minimal IT involvement. Changes can quickly be made as long as they can be expressed in the existing business object model. If not, the model and vocabulary must be expanded accordingly.

Rule engines use specialized algorithms like the Rete algorithm to optimize the rule condition evaluation (cf. [Fo82]), which typically leads to high performance execution of large rule bases.

Viewed from the pure rule engine or execution side, there are good open source or public domain rule engines available (e.g. Drools, Mandarax, Jess). However, they lack the rule management component, natural language definition capability of rules and support for decision trees and tables. These are features, which are indispensable to structure and maintain growing rule bases over time and to synchronize the business rule life cycle with the overall application lifecycle (see [Li04] for a business rule engine vendor evaluation for insurances).

Case study: BRMS for process improvements in a health insurance

This chapter presents a short case study that shows how a BRMS is used in a multinational health insurance company to improve the flexibility of their processes and to automate manual tasks.

Claims processing is a typical high volume process in health insurance companies. The clients submit bills of prescriptions and medical treatments from one or several doctors, requesting refunds based on the terms and conditions of their corresponding contracts. Besides underwriting (opening a customer relationship), it is the most important process for a health insurance company, since it has a direct impact on the net profit or loss.

Because of the variety of contracts in place, regulatory constraints and the high probability of errors or fraud, claims processing traditionally involves time consuming and costly manual processing steps. The overall goal is to achieve a higher degree of fully automated straight-through processing without manual interaction. Figure 3 shows the process which was implemented by a leading insurance company.

After receiving a claim the process starts with a document management step. Today, there are specialized scanning, classification and data extraction systems available to handle inbound documents, e.g. "smartFIX" for the health care insurance sector [IT06]. These systems are not only able to scan the document and put it into a document management system, but can also extract structured information like client name and address, type of document (e.g. prescription or bill), physician's name, address and specialization (internist, dentist, otologist, ...), drugs or treatment types. The output can be retrieved as structured XML document, for instance. At this stage of the process, a first set of rules gets executed: rules for classification and simple data validations.

The next processing step is to decide whether the current case is eligible for automatic processing or not. This is a content based routing decision, which is implemented by rules. The decision can be based on the amount of refund, the type of treatment and other criteria (see example in Figure 1). There are also situations, where the case needs to be split into subcases, which can be processed separately, for instance, an automated and a manual part. The underlying workflow system takes care of the overall process and provides functionalities like worklist management and persistent state.
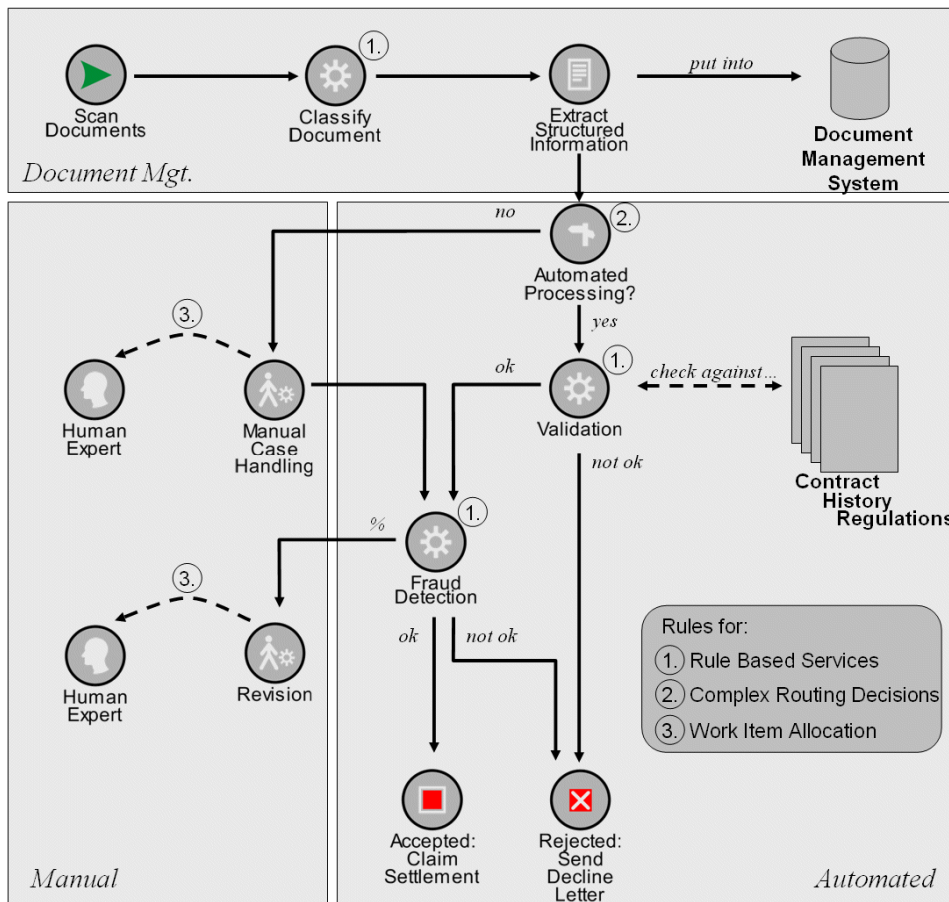

Figure 3: Business rules in claims processing

If a case is eligible for automated processing, several validation steps are performed. This includes checks if a certain kind of treatment is covered by the terms and conditions of the contract or checks regarding timeframes and allowed combinations of treatments. Typically, there are regulations which limit the billable amount for the different types of treatments, e.g. the "Gebührenordnung für Ärzte GoÄ" in Germany with several hundred of pages limiting chargeable amounts and possible combinations of billing positions. This is an example of government regulations as a source for rule definitions.

Fraud detection is also an important issue in claims processing. Besides the implementation of dedicated pattern-matching rules, a common paradigm is to route an adjustable amount of cases – e.g. a certain percentage – through a manual revision step. The case has to be assigned to the best-suited employee based on skill set, availability and workload. We use the term "Work Item Allocation" for this process step and it is also defined by rules captured inside the BRMS.

In summary, the main use cases of business rules, when coupled with business processes management, are:

- rule based services (e.g. calculating premiums and refunds),

- complex decision activities and content-based routing,

- work item allocation for manual processing steps.

Rule driven systems and processes have been successfully implemented by several major insurance companies. The typical technical infrastructure is based on a J2EE-architecture including a workflow system, a Java-based BRMS and integrations with existing host applications, e.g. realized with MQ-Series connections for asynchronous communication and batch runs.

There are also packaged solutions for claims processing in the health care sector, which use the paradigm of integrated business process and business rule management solutions. This product category includes, but is not limited to, Vitria SmartClaims integrating Vitria BusinessWare and ILOG JRules and solutions from PegaSystems. Graham [Gr05] discusses service-oriented business rule management systems in the context of a life insurance use case and provides an overview on this software category.

Besides claims processing, there are several other processes in the health care insurance industry, which can substantially benefit from the business rule approach:

- Underwriting: determine eligible insurance tariffs and calculate premiums,

- Product definition, configuration and pricing,

- Public backing for health care expenses for low-income families, children or elderly people.

Conclusions

In this article we described the relation between business agility and information systems. Service-oriented architectures coupled with business rule management systems form the basis of flexible eHealth business process management systems which adapt to changing business requirements. Business processes can be reconfigured in the process and service layer, changing rules are managed in the BRMS.

Business rules are defined by process owners who use a BRMS to manage them. The business rules approach enables them to capture knowledge, regulations, service level agreements etc. in formal rules.

Our health insurance case study showed, that manual routine tasks can be automated using a business rules approach, while more complex decisions and activities are performed by humans. One outcome was improved fraud detection. According to Light (cf. [Li04]) the degree of automatically handled claims in a process could be increased from 50% today to more than 80% in many health insurances.

Some of the business benefits of the presented information system architecture are improvements in processing speed, consistent enforcement of business rules, and flexible redesign of processes. This is all part of business process optimization in healthcare and shows the potential of eHealth.

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