FACULTY OF BUSINESS ECONOMICS
Master of Management: Management Information Systems

Masterproef
Open rules: An open source Business Decision Management System linking business and technology

Promotor :
Prof. dr. Koenraad VANHOOF

Dennis Swennen
Master Thesis nominated to obtain the degree of Master of Management , specialization Management Information Systems

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Preface

Organizations are constantly searching for ways to make their business processes more effective, less costly, and more agile. If companies want to survive these days, they need to be sustainable and deliver decent value; different strategies can be used and there is an increasingly growing trend which involves three technologies: The first is Decision Management where predictive analytics and business rules are used to optimize and automate decision-making, allowing the daily operational strategy to be controlled directly by process managers, rather than IT. Second, Business Process Management Systems (BPMS) that allow business processes to be modeled as sequences of activities, and then ensure compliance in those processes by executing the models. Third is integrating a Service-oriented architecture (SOA) by the use of software functionality as loosely coupled, reusable services, and encapsulate their internal logic to hide it from the consumers. Using a combination of all three technologies, it is possible to encapsulate business knowledge in services, consumed by the BPMS, which automatically make optimal operational decisions for the organization. This is called 'knowledge automation' and show in figure 1.
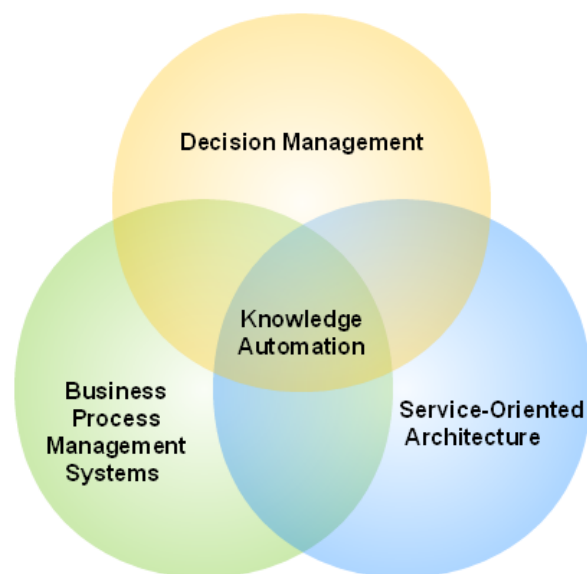

Figure 1: Knowledge Automation

Organizations can improve their comparative advantage by leveraging assets like business decisions and making their processes more efficient. The efficiency of the processes can be improved by eliminating bottlenecks, automating, better discovering and managing and sharing of knowledge that propagates throughout those processes. Mostly this information and knowledge is located in various artifacts throughout the company and not collected into a single, easy accessible source. For example, an ERP system can provide a company the ability to integrate the information flowing through the different departments. ERP systems bring the technological

infrastructure and management practices of the organization together and therefore it makes their processes more efficient.

Identifying and managing decisions within a process and automating them using business rules are critical next steps for greater efficiency and effectiveness in organizations today. The focus of automation to date has been on efficiency gains from streamlined work flow, automated integration of information systems and managed work lists. Many largely automated processes remain over-reliant on human intervention at critical junctures. Others are burdened with legacy code or complex processes to handle decision making and are unnecessarily resistant to change as a result. Combining business rules, process management and decision management decreases process complexity and increases business agility and engagement. By focusing on the decisions that create value, important (human) resources are made available elsewhere and companies become more profitable and more agile. (Owen, 2003)

The aim of this master thesis is to explore in which ways the growing domain of business rules management (BRM) and business decision management (BDM) can be used to improve the performance of business practices today and to create better decisions by applying it's structure and implementing the operational components. Business rules originate from the 1990s and decision management is a new, emerging trend from the last years. The latter is a topic researched more and more and seems to be an interesting topic to explore, including the challenges and advantages. This thesis will take a look at the structure as well at the implementation of the technology though models and operations.

The software tool OpenRules and it's functionality will be examined, supported by the literature that exists in this area. In the literature study of business rules, processes and decisions a lot of theory and models already have been examined. This thesis will provide a deeper analysis into BRM and BDM, applied and tested to the OpenRules software package. Conclusions will be made and a few pieces of advice for best practices will be given, based on the literature study, examples and the software case study. Further sub-questions will be formulated to answer the general research question and outline the structure of the whole thesis, comments on them will be given including some main definitions that will be preliminary for the whole subject. The sub questions will support the general research question - 'Can business and IT practices in a company be better aligned via Enterprise Decision Management?' - in finding the answers and practices to help businesses today make better decisions.

Summary

This thesis explores two things: First is the use and management of business rules, business decisions, the structure which is best applied and the systems, architecture and technology available today to make everything operational. A second view is that on business-IT alignment practices in using BRM and BDM.

First, chapter two on information and knowledge management describes the context of knowledge and information and business-IT alignment in general to provide the scope and focus for this thesis.

The third chapter starts with the exploration of the domain of business rules and business rules management systems (BRMS). This is an emerging practice to provide organizations with better information management and tools to manage business logic in a structured way, an enabler for a decision-centric approach of decision generation and modeling.

The fourth chapter is a deeper look into the structure and practice of BDM. It will provide an overview of the concept, the system architecture is explored, including several interesting and related components like decision services, decision automation and the Decision Model, providing useful information for supporting the subsequent research questions.

The exploration of the BDM domain reveals that a decent and rigid business logic is the foundation for a good implementation. Using this logic business decision discovery makes a company more aware of its decisions and making them potential items for decision automation. Highly complex strategic decisions still remain a human task, but lower-level decisions provide excellent content for automation. The next step is that the knowledge captured can be used to apply analytics and optimizations to make the business logic even more efficient. Companies are becoming more agile and capable of reacting to (or even predicting) possible scenario's that can be an advantage or disadvantage for the organization.

The firth chapter integrates the decision management concepts into business processes. The efficiency of the processes can be improved by eliminating bottlenecks, automating, better discovering and managing and sharing of knowledge that propagates throughout those processes. Identifying and managing decisions within a process and automating them using business rules are critical next steps for greater efficiency and effectiveness in organizations today. The focus of automation to date has been on efficiency gains from streamlined work flow, automated integration of information systems and managed work lists.

Chapter six takes a closer look to the service-oriented architecture, an architectural approach that seems interesting in supporting agile decision management and implementations. SOA is the current and next generation of architectural style for computer systems. It is a layered architectural style built around automated services. A foundation of SOA is the service inventory, and the quality of the SOA depends on how well the inventory is organized. With a common SOA-based architecture for decisioning applications across the services life cycle, IT can speed implementations and upgrades, simplify maintenance and training, and gain more ef-

ficiency and value from data, technology and analytic insights. The services-oriented approach also makes it easier to integrate third-party software with the current decision management applications.

In chapter seven, the OpenRules software is aiming to achieve this integration by designing the software to help business users allowing them to create, test, and maintain enterprise-class decision support applications. Combining several open source technologies make the platform an interesting approach in managing business rules and decisions, focusing on decision discovery, management, analytics and optimizations. Business users are in control, supported by, but less dependent on IT than traditional methodologies in realizing a decent the business logic to drive decisions.

The approach used by OpenRules is certainly a step in the right direction, although some components like a decent user interface and information feedback is lacking and the reliance on IT could also be improved. Decent projects still need IT support and due to OpenRules being not an all-in-one; beautiful designed software package, it can be a hassle for business users to get there business decision applications running smoothly.

Business and IT collaboration is still a topic that gets a lot of attention. This is justified as still a lot of companies are struggling to operate in a decent company structure. And in today's environment where IT almost has become a commodity and considered an disadvantage if not used, the collaboration and communication between the two departments becoming more and more important to create solutions that last. The alignment becomes necessary to survive and to add value.

Today, the domain of BDM receives a lot of attention and continues to be even more explored in the future. More in particular cloud solutions are investigated and implemented, a popular topic at the moment and considered to be even more important in the future. The use of business rules as services fits well in here, providing on-demand services in today's constantly changing business landscape.

The result of the thesis shows the importance and attention the topic is receiving today. As it is an emerging technology, yet a lot of work have to be done before it can be integrated effortless into businesses and if higher levels of maturity in business decisions want to be achieved.

Acknowledgments

Writing this thesis was not an easy assignment for me, as there were a lot of things involved, not only the writing part. I have learned a lot throughout my time at school, each year more and more and this thesis is the final creation of my University career. Although it is a finished chapter, the path of lifelong learning is still being walked.

I would like to express my gratitude to my Professor Koenraad Vanhoof. His knowledge, inspiration and support provided me with useful advice, motivation and ideas to make this project possible.

Thanks to my parents who have always have been kind, patient and have given me the opportunities and resources to make my education possible.

I wish to thank my friends for helping me through the good and difficult times, and for all the emotional support, entertainment and caring they provided. I would never have been able to finish my dissertation without their guidance.

It is a pleasure to thank the many people who made my education and this thesis possible. Thank you very much.

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1 Research questions

1.1 Problem statement

A business - referenced further on also as enterprise or company - is an organization engaged in the trade of goods, services, or both to consumers, which can be end-users or businesses. The latter are predominant in capitalist economies, where most of them are privately owned and administered to earn profit to increase the wealth of their owners. Businesses may also be not-for-profit or state-owned. Now to ensure the efficient and effective operation of a business, and study of this subject, companies practice what is called management. The major branches of management are financial management, marketing management, human resource management, strategic management, production management, operations management, service management and information technology management. We should not forget, developing and maintaining a business is truly an art. Technology is rising, business forms are changing and so does governance and management. Businesses are evolving towards extended enterprises, networked co-operations and global organizations scattered across the globe, combining resources, communication and knowledge to create a higher value.

A management information system (MIS) provides information that is needed to manage organizations efficiently and effectively and it involves three primary resources: people, technology, and information or decision making. Organizations of all types and sizes have issues related to effectively dealing with business change in a world where change is the one constant of doing business. Various situations create pressure on organizations due to the frequency of change and the need to respond quickly and efficiently.

Tools to flexible manage change and decisions in a company are emerging in the recent years. Companies start to notice the value of decisions and their impact on the organization, they are becoming decision-centric and focusing on Decision Management. They want to make better decisions by using the tools to make the discovery, management and analysis of their decisions. The value is becoming more clear through several projects focusing on the management of decisions, including the rise of tools supporting those practices. At this time of writing, BRM systems (BRMS) are emerging and becoming more reachable. Organizations start to use these systems more and more, looking for competitive advantages by using business rules and decisions as an asset, managing business practices better. Clearly, business rules represent one of the 21st century's major technological challenges. Industry analysts predict significant growth in the technology areas of service-oriented architecture (SOA), business process management (BPM), and BDM - also, and interchangeably, referred to as enterprise decision management (EDM). Major corporations investing in one or more of these technologies span all industries. The interest in these areas stems from a growing need to enable business agility, leverage current investments in IT infrastructure, and gain control over IT governance. (Halle and Goldberg, 2009a)

1.2 General research question

ResearchQuestion Can business and IT practices in a company be better aligned via Enterprise Decision Management?

1.3 Specific research questions

Question1.1 What are business rules and business decisions?

Question1.2 What is business decision management?

Question1.3 How can we integrate decisions into business processes?

Question1.4 Does the OpenRules software system provide a qualitative, reliable and user-friendly solution for creating and managing business rules and business decisions?

Question1.5 Does the OpenRules business decision management systems improve the collaboration between business and IT people?

1.4 Research Methodology

This research start with the explanation and exploration of different aspects related to BDM. The main method used is reading and analyzing the different resources like (Web) articles, papers, books and online reference material. As it is obvious, the domain of research is general business management, more particular decision management and the alignment between business and IT. The following chapters will provide a contemporary view on the domain of the problem statement and their basis and relevance for the research questions.

The first chapter on information and knowledge management describes the context of knowledge and information, business and IT alignment to provide the scope and focus for this thesis.

The second chapter starts with the exploration of the domain of business rules and BRMS. This is an emerging practice to provide organizations with better information management models and tools to manage business logic in a structured way, an enabler for decision-centric companies using decision modeling and management.

Specifically in a later chapter, the research is going to use the literature study and subject matter for evaluating and reviewing the open source software tool OpenRules. Previously, this tool consisted of a BRMS and has evolved recently into a BDM system. It will be used as case study for the current status of the development of management systems and as an example for the practical integration of decisions in today's organization.

The fourth chapter is a deeper look into the structure and practice of BDM. It will provide an overview of the concept, the system architecture is explored, including several interesting

and related components like decision services, decision automation and the Decision Model, providing useful information for supporting the subsequent research questions.

The firth chapter integrates the decision management concepts into business processes and chapter six takes a closer look to the service-oriented architecture, an architectural approach supporting agile decision services and their implementation.

Further on we will take a look at the alignment and integration between business and IT. This part supplements the OpenRules© case study where the collaboration between business and IT users is an important highlighted topic.

The result this thesis wants to provide is a critical and contemporary exploration of BDM structure and its operation via the review of the OpenRules software tool and providing valuable advice and insight for aligning business and IT practices to make better business decisions, creating a high value added.

2   Data, Information and knowledge

The preface talked about knowledge automation and one definition of knowledge management is "a range of strategies and practices used in an organization to identify, create, represent, distribute, and enable adoption of insights and experiences. Such insights and experiences comprise knowledge, either embodied in individuals or embedded in organizations as processes or practices."

Knowledge is what we know. Data are the facts, the description of the world. Information allows us to expand our knowledge beyond the range of our senses. We can capture data in information, transfer and store it so that other people can access it at different times. Until people started using information, all they could use was the data directly. Knowledge was limited by direct experiences. However as it is clear, a lot has changed in the digital age.

Consider a management information system, it provides information that is needed to manage organizations in a decent way, as seen in Problem statement. Management information systems and the information it generates are generally considered essential components of careful and reasonable business decisions. An information system is viewed and used by management at many levels in the organization. It should be supportive of the organization's longer term strategic goals and objectives. To the other hand it is also those everyday operating systems that are used to ensure basic control is maintained over the low-level operating activities.

(Nowduri, 2011) states that information generally is referred to as analyzed data. In other words, information (with regards to business) results from data that is analyzed using business statutes, principles and theories advanced and complemented by various macroeconomic factors that influence the business. Knowledge is the information a business is aware of and which is available for the people inside the organization. Knowledge can be represented in a various number of ways like cases, nodes in a network, tables and most important: business rules.

2.1   Rule-based systems

In fact, this is the most common form of knowledge representation. Knowledge management and knowledge automation are related to business rules. For people inside the company, the goal is to codify the knowledge of the company's best people and make it available to workers at lower levels. ('Lower' here generally means 'lower cost'.) For customers and others outside the company, they want to codify what the 'middlemen' know, and to reduce or eliminate their involvement. In either case, the knowledge must be captured and codified. This means: business rules, pure and simple. In short, those parts of enterprise knowledge you can codify are business rules. (Ross, 1998)

The number of rules determines the complexity of the system, from a few to many thousands. Rules are appropriate when knowledge can be generalized into specific statements. Knowledge acquisition is a tedious and expensive process. In section §7 of the research, there

will be a specific approach and evaluation of the OpenRules BRMS, an open source software management tool for harvesting and managing business rules.

2.2 Types of knowledge

Essentially, a business process in an organization is procedural in nature, but a business rule or decision are declarative in nature. However, without a clear understanding of declarative versus procedural nature, common practice involves creating business process models in which business rules and decisions are loosely represented as just another part of the business process. In other words, it is common practice to model business processes and business decisions in a procedural manner rather than modeling the latter in a declarative manner. This common practice not only constrains the business decision unnecessarily, it seriously hinders agility for both the business process and the business decision. Understanding the difference between a business process and a business rules or decision means distinguishing and preserving the difference between a procedural versus declarative solution.

Procedural knowledge, also known as imperative knowledge, is the knowledge exercised in the performance of some task. Procedural knowledge, or implicit knowledge is different from other kinds of knowledge, such as declarative knowledge, in that it can be directly applied to a task. For instance, the declarative knowledge (known from the beginning) one uses to solve problems differs from the procedural knowledge (retrieved during execution) one possesses about problem solving because this procedural knowledge is formed by doing.

Descriptive knowledge, also called declarative knowledge or propositional knowledge, is the type of knowledge that is, by its very nature, expressed in declarative sentences or indicative propositions. Declarative knowledge represents a static representation, knowledge about objects, events etc. and their relationships and states given. It requires a program to know what to do with the information and how to use the knowledge. Declarative knowledge involves knowing *what* something is - that B is the second letter of the alphabet or that Brussels is the capital of Belgium. It is conscious; it can often be verbalized. (Koedinger and Corbett, 2006)

Procedural knowledge involves knowing *how* to do something - ride a bike, for example. We may not be able to explain how we do it. Procedural knowledge involves implicit learning, which a learner may not be aware of, and may involve being able to use a particular form to understand or produce language without necessarily being able to explain it. Procedural representation controls information necessary to use the knowledge and is embedded in the knowledge itself. e.g. how to find relevant facts, make inferences etc. and requires an interpreter to follow instructions specified in knowledge. (Koedinger and Corbett, 2006)

2.3 Knowledge management

Information system models commonly describe organizations in terms of the structure of the data they use, the organization of the processes they perform and the operations that will be

executed. Compliance with regulations and verification of business rules is difficult when a considerable amount of business knowledge is only represented in code or database constructions and is not modeled in an explicit way that is easy to understand and verify. When properly defined, research reveals that decision tables offer a solution to several issues in the modeling and verification of regulations, such as guaranteeing consistency, correctness, non-redundancy and completeness. Decision tables are popular and have been used in various cases. (Vanthienen et al., 2010) A second approach is that one of a rule-based system, already briefly introduced and in a more advanced model; Decision Models, a concept also explained further on in the thesis.

2.4   Closing the gap

The parts of enterprise knowledge that can becodified are business rules. But how can this knowledge be harvested, existing in various places scattered around the enterprise. Therefore we first will look at a problem that is common in today's enterprises: the collaboration between different departments and their people, in particular business and IT.
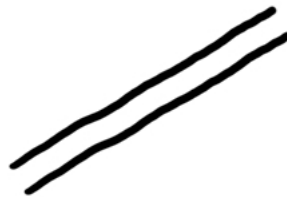
Figure 2: Three lines

How many lines are there in figure 2?

There's the first line, the second line, but then there's a line of negative space that runs between them. We need to close that space in the collaboration between business and IT, an often overseen and difficult to close gap.

There is a difference between business and technical users. They both have a different background and a different view on how things are handled. If they use any software, because of different background knowledge or no knowledge at all, the way they handle the software will also be different. In work environments nowadays people with different skills often need to work together to create decent and usable solutions. The different roles for business and technical

people are present in the first place, two different jobs with different responsibilities, too difficult to manage by a single role. Knowledge in more than one domain by staff and management is becoming more and more important, even necessary to operate in today's businesses. By specializing and separating the positions, better results can be achieved. However this is only the case when the work of both parties is merged together in the right way. Where there is a bottleneck and for example information is transferred in the wrong way or not understand, the value of the work is lost. It is of major importance to align these two specialties, supported by software which nurtures standardization, collaboration and communication. It has to be possible for the information to be stored and transferred in an understandable and usable way. The typical mismatch between the goals of the business and the actual computer code in business applications is due to programmers not understanding the business logic and business analysts not understanding what is happening with the code.

2.5 Summary

A few broader concepts like data, information and knowledge have been defined. These terms are often misunderstood and there is more to know how to manage data, information and gather the knowledge present inside a company. Business rules seem a decent and best-practice approach. Also people inside organizations have to work more closely together to close the gap in the misunderstanding between people and practices, especially between business and IT practices. Now in the next chapter, the management of knowledge via business rules will be further examined.

3 Business Rules Management

Business rules tell an organization what it can do in detail at the micro, operational level, while business strategy tells it how to focus the business at a macro level to optimize results. Put differently, a strategy provides high-level direction about what an organization should do. Business rules provide detailed guidance about how a strategy can be translated to action.

These rules exist in many organizations as intangible objects, scattered around in the company in various forms. Anyhow, these rules exist in an organization whether or not they are ever written down, talked about or even part of the organization's consciousness.

Broadly speaking, business rules are constraints: They define conditions that must hold true in specified situations. Sometimes called invariants, business rules are not descriptions of a process, but declarative statements as has been seen before. Rather than being procedural, business rules are declarative and define the conditions under which a process is carried out or the new conditions that will exist after a process has been completed. The word 'process' is used here in the general sense. Putting this another way, business rules define what must be the case rather than how it comes to be. A set of rules that define pre- and post-conditions can act as a specification for a process, without constraining the mechanisms through which the preconditions are transformed into the post-conditions, in other words how the process is executed. Business rule statements in the business model define the desired logic of the business. They describe a state of affairs that the business wants to exist - in fact, what the business demands. From a more technical approach, if they were to be expressed as Boolean functions, which evaluate true or false, business rules would always return a value of true. Otherwise they would be pretty useless as a definition of the desired logic. From a logical business rule perspective, there are no exceptions; there are only rules.

A supposed exception to the business logic is simply another business rule. This should not be confused with what happens after the rule has been implemented. During processing, conditions may exist that would result in false if the business rule were to be evaluated. The whole point of the business rule approach is that it identifies the conditions that need to be detected and the corrective action (decision) that's required to restore the system to a state in which "true" always prevails. Typically, these rules and decisions are used inside procedures, which we'll consider in more detail in a later chapter. Once a process has reached a stable state - has completed or aborted - it must not leave the system in a condition that violates any business rule. (Morgan, 2002)

3.1 Scope

BRM is categorized as a component within the Service Type of Management of Process, as shown in Figure 3. It is aimed to "manage the enterprise processes that support an organization and its policies", as explained to check if processes run smoothly and are in line with the business objectives. Clearly, business rules represent one of the 21st century's major technological
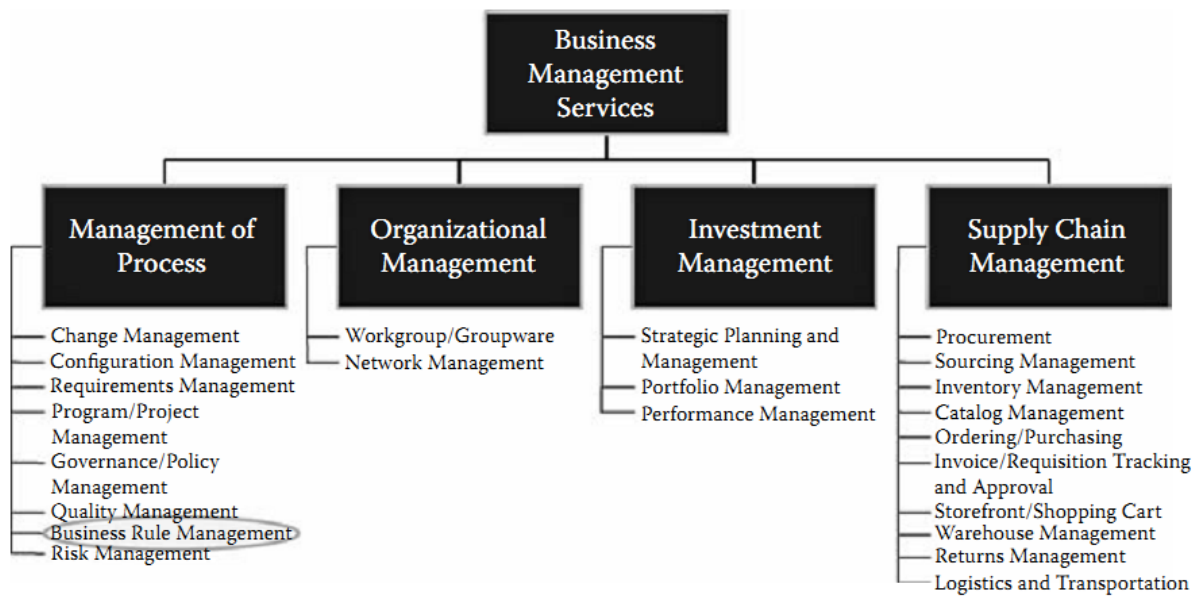
Figure 3: Business Management Services Domain. Source: Halle and Goldberg (2009a)

challenges, and if we are to create a new generation of large-scale information systems that are agile, adaptable, and predictable, then we must have repeatable methods for developing consistent business rules. (Halle and Goldberg, 2009a)

Business rules represent the expertise, tribal knowledge, regulations and policies that drive a business. Mining business rules from software code, reviewing regulations and policy manuals, interviewing experts and many other techniques can be used to find the rules that support the decisions. (Taylor, 2011a)

The policies and procedures that drive how a decision is made, can and should be represented using a declarative definition of what should be done. Business rules are a suitable solution. Business rules are declarative, expressive, and easy for non-technical users to understand, making it possible to define how a decision is made completely and correctly. Properly deployed, the use of business rules adds agility to the decision services by involving the line-of-business experts directly in maintaining the decisions being executed. It essentially eliminates the go-between programmer and places rule management in the hands of those responsible for revenue or cost.(Taylor et al., 2011)

3.2 Business Logic

The fact is that all organizations operate in accordance with a set of underlying principles—that's what "organization" means. There's scope for plenty of variation in the principles adopted by different businesses, even in the same sector, because of the need for differentiation in the market. Among other things, these principles define the "business logic" that governs the way

in which the business conducts itself. However, there are also many points of similarity: some arising because of common external forces, such as legislation, and others because of common goals, such as revenue generation. It's certainly true that businesses are not always fully aware of their own business logic. Often, many factors that crucially affect business operations are buried in dusty office memoranda, informal local practices, "folklore," or even oral agreements vaguely defined ages ago. The aim is to replace all this with a set of clear and unambiguous statements that describes how the business intends to conduct itself. (Morgan, 2002)

A more formal definition of business logic is "A means by which a business derives a conclusion from facts." So, business logic is a prescription for the way business experts want to evaluate facts in order to arrive at a conclusion where the conclusion has both meaning and value for the business (knowledge). Therefore, a business decision is defined as a conclusion that a business arrives at through business logic and which the business is interested in managing. To make business logic tangible, common practice is to translate the business thinking into a visible, communicable form, which often is a set of business rules or business statements. These artifacts vary in format: free-form text, fill-in-the-blank templates, decision tables, decision trees, or sentences in a language specific syntax or grammar.

The business logic is the underpinning of an organization's identity, integrity, innovation, and intelligence. Business logic represents the policy, the "rules of the business" that operate perhaps unknowingly thousands of times a day in the company's services to customers and partners. They are the past, present and the future of the company. Business logic represents business thinking about the way important business decisions are made.(Halle and Goldberg, 2009a)It is the bridge between policy and execution. It is the set of business policies and procedures that execute a corporation's value proposition to their customers and provides real differentiation against competitors. The reason it is so difficult to innovate in operations is that it has been difficult for businesses to create and maintain the business logic that represents a company's policies. This is where business process management, implemented correctly, can help. Model-driving applications allow business analysts to change, manage and redeploy the business logic largely independent of the IT effort. (Minsky, 2005)

3.3 Business Rules

Business rules were introduced in the previous chapter as an appropriate means to generalize knowledge into specific statements. A business rule is a statement that defines or constrains some aspect of the business and always resolves to either true or false. A certain amount of conditions are tested which lead to a conclusion for the situation at hand. Business rules are intended to verify business structure or to control or influence the behavior of the business. They describe the operations, definitions and constraints that apply to an organization. Business rules can apply to people, processes, corporate behavior and computing systems in an organization, and are collected and defined to help the organization achieve its goals. For example

a business rule might state that no credit check is to be performed on return customers. Other examples of business rules include requiring a rental agent to disallow a rental tenant if their credit rating is too low, or requiring company agents to use a list of preferred suppliers and supply schedules. While a business rule may be informal or even unwritten, writing the rules down clearly and making sure that they don't conflict, is a valuable activity. When carefully managed, rules can be used to help the organization to better achieve goals, remove obstacles to market growth, reduce costly mistakes, improve communication, comply with legal requirements, and increase customer loyalty. (BusinessRulesGroup, 2001)

3.3.1 Rule harvesting

Organizations gather business rules, a method which is called rule harvesting or rule mining. This may happen in one of two ways. Organizations may choose to proactively describe their business practices, producing a database of rules. While this activity may be beneficial, it may also be expensive and time consuming. For example, they might hire a consultant to come through the organization to document and consolidate the various standards and methods currently in practice. More commonly, business rules are discovered and documented informally during the initial stages of a project. In this case the collecting of the business rules is by coincidence. In addition, business projects, such as the launching of a new product or the re-engineering of a complex process, might lead to the definition of new business rules. This way rules are added to the business logic in several different iterations.

This practice of coincidental business rule gathering is vulnerable to the creation of inconsistent or even conflicting business rules within different organizational units, or within the same organizational unit over time. This inconsistency creates problems that can be difficult to find and fix. Allowing business rules to be documented during the course of business projects is less expensive and easier to accomplish than the first approach, but if the rules are not collected in a consistent manner, they are not valuable. In order to teach business people about the best ways to gather and document business rules, experts in business analysis have created the business rules methodology. This methodology defines a process of capturing business rules in natural language, in a verifiable and understandable way. The process is not difficult to learn, can be performed in real-time, and empowers business stakeholders to manage their own business rules in a consistent manner. The business analyst or consultant can extract the rules from IT documentation (like use cases, specifications or system code). They may also organize workshops and interviews with subject matter experts (commonly abbreviated as SME's). Software technologies designed to capture business rules through analysis of legacy source code or of actual user behavior can accelerate the rule gathering processing. (Halle, 2001)

While many of the business rules used to make a decision come from written and explicit sources – regulations, policies, procedures, user preferences – it is often necessary to extend

the process and include data mining to create and improve business rules. Data mining tools typically "see" facts and probabilities that the people involved would not be able to detect on their own. Many rules have thresholds, or limits, in them, and data analysis can be used to find statistically significant or historically effective values. Data mining can also be used to develop segmentation models and these are often represented by business rules as well. Essentially, by analyzing data one can make the rules better reflect what works, or at least what has worked in the past.Taylor et al. (2011)

3.4 Business Rules Management System

As seen before yet many "rules of the business" are buried somewhere in program code or in people's heads. Sometimes even, the business rules executing in program code are not what the business thought they were or what the business needs them to be. However often neglected, they are an important consideration in implementing change and delivering enterprise agility. In a lot of cases today's approach to using rules is that they operate as a silent, invisible business asset rather than one worthy of being managed separately from other dimensions. As a result, they remain buried, scattered, and not flexible to a changing business.

Even when captured separately from models and requirements, the technology for storing business logic ranges widely from documents, spreadsheets, modeling tools, repository tools, and proprietary software, to home-grown databases. They are managed as a catalog or list of business rule statements, tied in one way or another to related deliverables. This way they are not managed in a common model as data should be managed today. The historic impact of a common model for data is worth speculating.(Halle and Goldberg, 2009a)Business rule management systems can also use decision tables to implement the models that result from data mining and analytics techniques. (Taylor, 2011a)

(Owen, 2003) says "a basic rule of technology is that you only get smart results from smart tools." One such "smart tool" is a business rule management system (BRMS) that takes business logic out of procedural code and puts it where it belongs: in the hands of business analysts. A BRMS can extract and isolate business rules from all of the other control code in an application, allowing business analysts to configure the rules using simple if-then-else statements and ordinary business language. Further on in 4.8 the Decision Model will be discussed, a logical model for representing business rules which is another step closer to guide the decision making process.

In figure 4 the components of a typical business rule management system are shown. Concepts like the business logic (or rule repository) are already explained. The diagram shows how via design tools and rule management applications rules are collected in the system. From there on they will be executed by what is called a rule engine and under the form of decisions service used in business processes. More details on various components will be explained further on in chapter 7 on page 67, The OpenRules® platform.
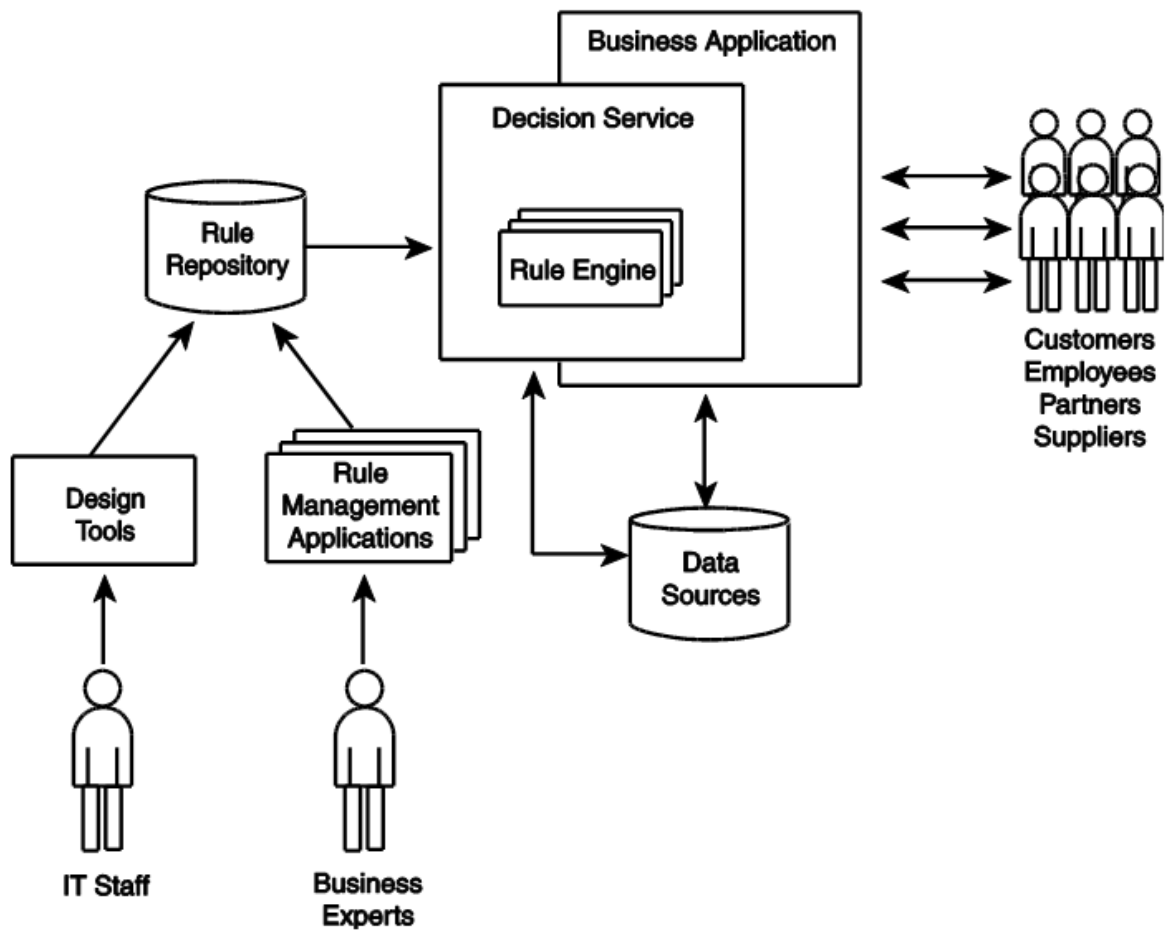
Figure 4: Components of a BRMS. Source: Taylor (2011a)

Focusing on the business rules for a specific decision helps avoid a common problem in business rules implementations. When business rules are everywhere in an organization, collecting and managing those rules without an organizing driver can result in lots of rules being managed for relatively low business impact. Certainly everyone understands the rules better and it is easier to find and update them, but the company will not maximize the return from this investment unless business performance has improved as a result. Focusing on the decisions ensures that this will be the case. A focus on decisions increases the value of a rule repository and of an effective system for managing rules. (Taylor, 2011a)

A best-in-class BRMS will provide appropriate tools for both technical users and business users. Business users are able to author and change rules, working in familiar ways ("if, then" syntax, decision tables, decision trees, etc.). They are also able to add analytic models into rules-driven decisions, now or in the future, without having to ask IT to recode them for operational deployment. The OpenRules software, further on reviewed in this thesis, has a lot of useful tools for managing business rules. It will be clear further on if these advantages are present in the software.

3.5   Summary

Business rules provide detailed guidance about how a strategy can be translated to action. However in a lot of cases they are scattered around the company and not well managed. A better way is to create a system with a decent business logic, a place where the knowledge of an organization is translated into business rules.

While there are many reasons to use a BRMS, its use as a platform for BDM (see next chapter) is the most powerful. A good implementation takes business logic out of procedural code and puts it where it belongs, in the hands of business analysts and leaving the IT people creating the architecture and systems to implement the applications. A BRMS allows both technical and business users to work independent on the rules for a decision and many of these systems can integrate analytic models as part of the decision-making framework. Indeed most of the established BRMS are migrating towards becoming Decision Management Platforms. (Taylor et al., 2011)

4   Business Decision Management

4.1   Introduction

In the last few years is when BDM has entered the business intelligence (BI) space. It is one of the tools of business intelligence (BI), which is defined as the ability for an organization to take all its capabilities and convert them into knowledge, ultimately, getting the right information to the right people, at the right time, via the right channel. (Rud, 2009)

Business decision management refers to the application of rule-based systems - in alignment with analytic models - to automate, improve, and distribute decision-making capabilities across an organization. This can produce large amounts of information which can lead to the development of new opportunities for the organization. When these opportunities have been identified and a strategy has been effectively implemented, they can provide an organization with a comparative advantage in the market, and stability in the long run. Tools and state-of-the-art technology in this world have become more and more available and increasingly intelligent, an evolution that is far from stalling. More and better resources are being used in operating businesses, some even becoming a commodity and necessary for survival in the modern ages.

Currently, BDM is most commonly used to automate customer-interaction decisions associated with revenue-generating activities - such as marketing, product recommendation (i.e., personalization), up-sell/cross-sell offers, and pricing. However, decision management is also seeing increasing use for automating other types of high-volume, mostly less complex decisions, such as guidance and employee support, forms and data management, and work-flow and process control. (Hall, 2005)

Decision management increases the value of business processes by making them simpler, more flexible and agile. With decision management the business rules that capture decision logic (e.g., policies, regulatory requirements) no longer have to be hard-coded into business applications, with all the costs and time delays that entails. Like it is mentioned in the previous chapter, the decision logic is managed separately by a BRMS and becomes a 'decision service' that responds to business questions by making decisions according to the business logic, whenever the service is called up on. Questions can be like "Should this application be approved?", "Should this credit limit be raised?" or "Should this account be targeted for a retention offer?". BRMS is a sub-part of decision management as the business rules become the foundation for the decision services to find answers for the posed questions. Separation from other system code makes the decision logic easier to understand and change. It also makes business applications more robust, since with the separation of decision logic—the code most subject to change— applications require fewer updates.

They replace hard-coded decision logic within business applications with independent decision services built using a BRMS. And finally they close the loop with decision analysis, ensuring that the way decisions are being made is monitored and the results constantly improved.(Taylor, 2011b)

4.2 Approach

BDM is an approach that allows organizations to move away from a reliance on systems towards one utilizing decent processes, rules, and intelligence. Three elements summarize BDM: business motivation, business logic, and business metrics, the elements which interact to create "smart" business systems, the overall goal of BDM:

- Business motivation: This is the general business plan, and the specific business objective's within that business plan, that the business decision is meant to implement.

- Business logic: This is the logic underlying the business decision that is implemented to achieve the business objective, explained in 3.2 on page 22. This business logic is formulated to best deliver the business metrics set by the business objectives. The role of modeling business logic in BDM as we will see further on, is to maintain a stable, normalized and complete representation of that logic.

- Business metrics: These are the measurements and time periods that are set by the business objectives, and that must be achieved by the business. These metrics are arrived at in the business planning phase, and may be supported by predictive modeling techniques.

The integration – in design, implementation, management and governance – provides the necessary foundation for an enterprise to truly focus on its business and recognize its decisions as true corporate assets. By focusing on the decisions that create value, companies become more profitable and more agile. Companies emphasizing a BDM approach focus on operational decisions, using business rules to manage the decisions and ultimately enable those decisions as services tied to their core business processes. Not only does BDM focus on the business value of business decisions and their models, BDM also advances BPM and SOA by promoting business decisions to the status of a visible asset worthy of management. (Halle and Goldberg, 2009a) More on integrating BPM with SOA can be found in chapter 6 on page 55, 6 on page 55.

BDM solutions that automate, improve and connect decisions to enhance business performance are based on a number of technologies, of which some are already explained briefly before, including business rule management systems, business process management systems (BPMS), business intelligence (BI) and service-oriented architectures (SOA). In choosing a BDM solution, the focus is mainly on:

- Vendor platform evaluation, assessment, and selection

- Methodology, design, process view, rule harvesting, and decision analysis

- Implementation and extend of the different BDM services; processes, rules, analytics, SOA

There has already been done a lot of research in several domains within the field of BDM systems, business logic structuring using decision tables, tabular decision models and business rules: tabular decision modeling in general, normalization of decision models, decision structures and network models, types of decision tables, verification and validation, modeling methods and tooling and its applications.(Garcia et al., 2000)(Baesens et al., 2003)(Reusch et al., 2007) A more profound analysis of those modeling techniques is beyond the scope of thesis and will not be addressed in detail. However some modeling techniques like simple decision tables and the Decision Model are reviewed in the context of the OpenRules software further on in the thesis.

4.3   Overview

To describe BDM tools, three main approaches can be used: 'decision management applications' (DMA), focused on the automation and improvement of a specific class of decisions, are the most widely deployed and best known. They isolate the logic behind business decisions from the mechanical operations of application procedural code. A DMA also makes it possible, to use predictive analytics as an built-in part of a real-time decision process. BRMS go a step deeper and can be used to manage decisions for which analytics are less important, such as compliance, or by including executable analytic models as "black boxes". And finally there are decision management platforms, making it possible to manage a wide variety of models and rules for many different decisions are increasingly common.(Taylor et al., 2011)

Capturing the know-how of experts in explicit decision logic and making it available everywhere focuses the scarce expert resources where they deliver the highest value, This way, staff can focus more time on value-add activities that require their expertise, on exceptions and high-value cases and customers. The number of exceptions can also be systematically reduced over time by developing new rules as process execution is observed - observing process performance, identifying new rules to handle particular cases, and automating those rules results in continuous improvement and process optimization. The agility and flexibility of the process, and of the underlying business applications, is constrained by the flexibility of the components being shared. Yet the components of a business application most useful to business processes, are often decision-making components such as pricing engines, product configurations or eligibility determinations. And these decision making components must change often - they are among the most dynamic parts of the application. Decision Management ensures that shared components are flexible.(Taylor, 2011b)

4.4   Main components

The components of a BDMS are displayed in figure 5. Four aspects, potential benefits of building a BDM system drive organizations to adopt the new technologies:

- Managing decision logic for transparency and agility
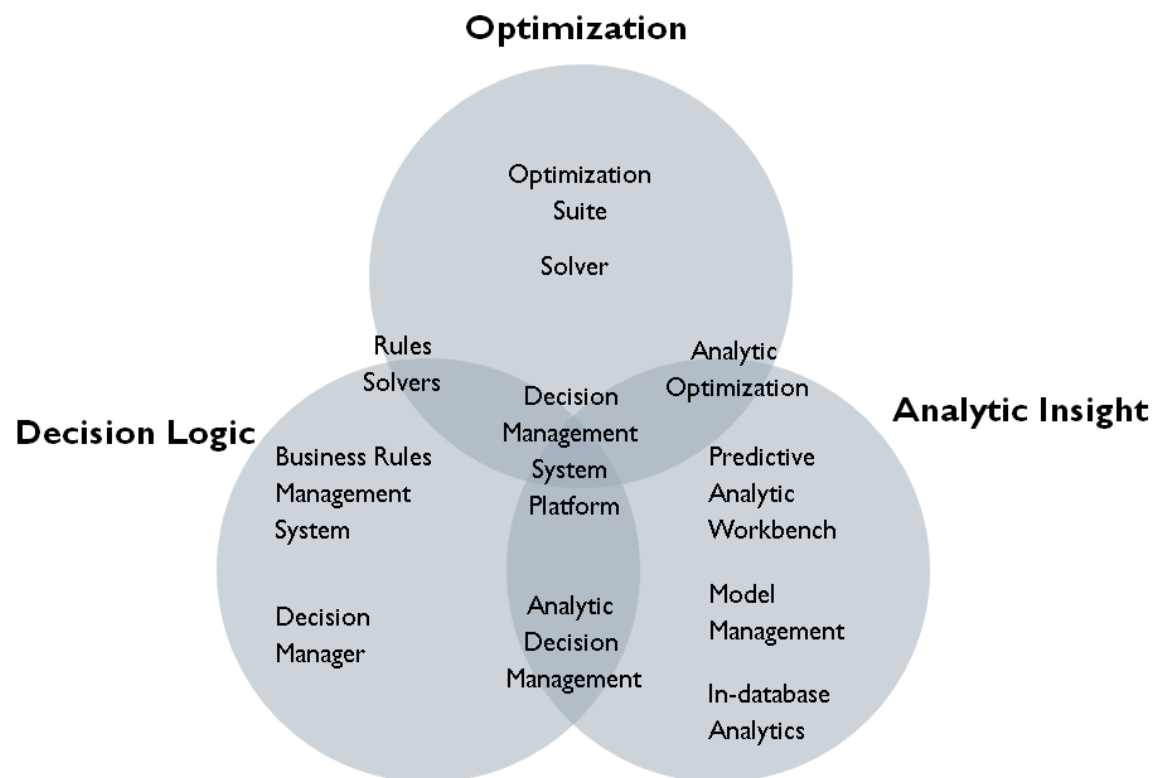
Figure 5: Decision Management Components. Source: (Taylor, 2012)

- Embedding predictive analytics for analytic decision-making

- Optimizing results given real-world trade-offs and simulating results

- Monitoring and improving decision-making over time

Managing Decision Logic

For information management, a rigid and structured decision logic is an important requirement to deliver design transparency, so it becomes clear how the decision will be made, and execution transparency, so it becomes clear how each specific decision was made. To manage logic in this way most organizations will adopt a BRMS or a product that contains equivalent functionality.

Business rules are atomic, declarative statements of business intent and they implement the policies, regulations, know-how and expertise critical to decisions. They are used as the core building block of operational decisions, which is also the core focus of decision management. These decisions are not the strategic, high-value decisions of management consultants and CEO's. These decisions are those required to make day to day operations run effectively. They ensure that customers are treated consistently, that the right price is offered, that the most effective offer is made. While the value of each individual decision is small, the cumulative effect is very large because organizations make these decisions often. (Taylor et al., 2011)

Embedding Predictive Analytics

One of the most powerful features of decision management is the ability to bring analytics into play. Predictive analytics includes data mining – used to investigate data and derive trends and characteristics that can be represented as business rules – and predictive analytic models that predict how customers might behave in the future. Decision management allows these insights to be applied not just to broad statements or corporate strategies, but deep down into day to day operations. Organizations applying decision analysis use performance management techniques and technologies to continually evaluate their performance against metrics and monitored processes. To continuously improve business performance, process performance, throughput and basic statistics can be monitored. How many decisions are made to approve, reject or refer is a measure of decision effectiveness. Too many referrals will increase the burden on staff doing manual reviews. Too many rejections, thanks to false positives for instance, will impact customer service or sales. Similarly, decisions that take too long or that cost too much (because they use data that must be purchased, for instance) may have a negative overall impact. Tracking and reporting on this information will help the business owners understand and thus manage their decisions more effectively.

A combination of systems and human interaction is the best approach; letting the system managing the literal data, visualizing and reporting it to people who than can use their judg-

ment to make better decisions. This shift from presenting data to humans, so that they can derive insight from it, to explicitly embedding analytic insight in systems using predictive analytic techniques means that organizations will need to adopt additional technologies to analyze their data. The right use of decision analysis, combined with human knowledge can become a critical and high valued. With a decision management approach, the business understands how specific decisions create value. Although many rules are written based on judgment, tribal knowledge, regulations and policies, this information can be augmented by using data mining and analytics to find or refine business rules. Increasingly common, this approach can be an important complement to business rules for some decisions.(Taylor, 2011a)

Optimizing Results

Optimization complex trade-offs and contradictory constraints can be hard to manage in decision-making systems. Technology can find optimal or at least feasible solutions based on the business constraints and objectives. Whether making a workable decision or finding the set of decisions that generate the best overall results, optimization is a powerful technology. Many decisions rely on resources that are not unlimited. There is no point where all, perfect information is available. Organizations will need to adopt optimization and simulation technologies to manage trade-offs and to ensure that decisions are made in a way that produces the best possible results given the constraints on decision-making. These technologies allow modeling of the constraints and trade-offs and then use mathematical techniques to pick the set of outcomes that will maximize the benefit to an organization. Models like this can also be used to drive test cases and simulations of various scenarios to see which will produce the best outcome for the organization. (Taylor, 2012)

Monitoring and Improving

Decision analysis applies these same techniques to constantly monitor and evaluate decision performance so that the impact of decisions on the business can be assessed and used to improve decision making. The nature of decision-making is that it is often not possible to tell how good a decision will turn out to be for some time. As a result the ongoing monitoring of decisions made and their outcomes is really important. Such monitoring allows for decision-making to be systematically improved over time both by tracking decision performance and making changes when this performance is inadequate and by conducting experiments and analyzing the results of these experiments.(Taylor, 2012)

Decisions are not stable. Effective decisions must be monitored and managed over time so they can be continually improved. Performance management tools and techniques can be applied to operational decisions. This allows the distribution of decision choices, results of specific choices, and overall rates and volumes to be measured. Adaptive control techniques can also be used to continually compare the "champion" or current approach with "challengers."

Champions and challengers represent sets of business rules and predictive analytics that form a decision beneficial to the enterprise. The champion is the current production solution, the challenger is a possible replacement. These challengers change some aspect of the approach – new models, new rules – and are applied to a small percentage of transactions. If one of them performs better over time than the champion, it can be promoted to the champion and new challengers are devised. This constant challenging leads to continual improvement and helps ensure that changes outside the organization don't lead to a decision being made poorly for an extended period.(Taylor et al., 2011)

4.5 Decision Context

A business decision is a conclusion that a business arrives at through business logic and which the business is interested in managing. Why are the broad spectrum of business decisions, such as those in figure 6, so important? (Taylor and Raden, 2007) state that "organizations are perceived through the lens of the decisions they make". Business decisions vary in character a great deal, and are not made in a separate vacuum. There are three characteristics of a business decision that are important to its business value:

1. Each business decision has an operative context. The operative context is the complexity of the business environment (horizontal axis on figure 6) in which the business decision is made. The complexity of the business environment may range from simple to very complex.

2. Each business decision varies in its volume-based economic impact (vertical axis on figure 6). Each instance of a business decision has an economic impact on the business. An instance that is strategic in nature - to acquire another company, for example - may have a greater value and economic impact on the organization than an instance of a business decision to grant a particular level of discount to a given group of customers. And than there is also the frequency of how often a decision is made, which is called it's volume.

3. Each business decision varies in the complexity of its business logic.

The impact of decisions on a business cannot be viewed isolated and is a function of all three characteristics; context, volume and complexity. Each characteristic measures a different aspect of a business decision and is evenly important.(Halle and Goldberg, 2009a) A BDM system is not simply a decision modeling tool or a front-end add-on to a particular business rules management system. A BDMS supports customizable full life cycle business-to-IT governance of business decisions and decision model deployment.

Figure 7 shows such a life-cycle, an example decision work flow from start to end. It starts with a business initiative, a business person defines a customized governance work flow for
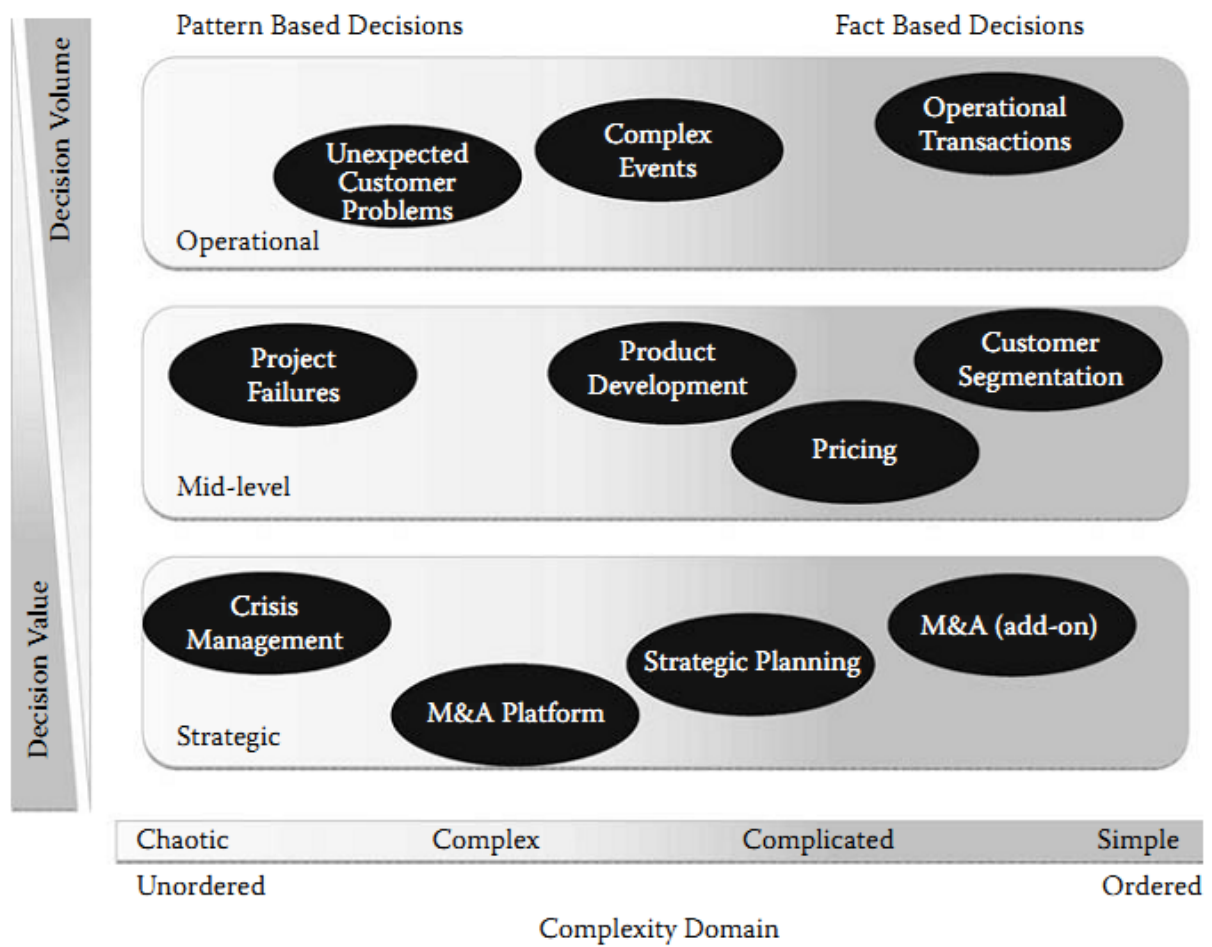
Figure 6: Categorizing business decisions. Source: Halle and Goldberg 2009a

approvals from specification to testing to production. The cycle continues with a decision model creation or change. It progresses to automatic validation of entire decision models against the Decision Model principles, which automatically detects all logic errors, including automated full decision model testing. Notice that these steps can be executed with a minimum of IT support.

4.6   Discovery

Companies adopting decision management use what is called decision discovery to find the decisions that matter to their business and drive the results they seek. Note that there is a difference between business rules and business decisions. The latter are one step further in the process and come from taking the combination of processes and rules to conclude to a decision. We have already spoken previous about the different components; the business rules and logic.

Each decision requires a number of sets of rules – rule sets. These are coherent groupings of rules that can and should be used together. Some decisions require a single rule set and some require many. Those decisions, boiled down from applying business rules in the company processes, backed by a business logic eventually support the decisions and contribute a big deal in realizing the objectives the company has set. (Taylor, 2011a) states that having discovered the decisions that run a business and contribute to its key performance indicators (KPI's), the next step is to prioritize them for the application of decision management. An organization needs to know how likely it is to show a strong return on investment (ROI). Good candidates include:

- Manual decisions, made by supervisors because automating them will empower others to make those decisions directly, reducing referrals and increasing first call resolution.

- Manual decisions where more than seven factors must be considered as people are not good at handling complex trade-offs.

- Inconsistent decisions where the website gives one answer while the call center gives another or where different call center representatives give different answers are good candidates as the management of those decisions can eliminate inconsistency.

4.7   Automation

High level strategic and more complex decisions are not so easy to automate. As it would also not be of much value. The volume and frequency of these decisions is rather low, which makes them less suitable for management and especially automation. Higher value, higher complexity decisions, such as defining a new strategy, acquiring a company or designing a new product, require human expertise rather than an automated process of more simple daily decisions.

As the value of the decisions decreases and the volume increases, it becomes more and more interesting in managing, automating and optimizing those decisions. On a basic level

start

Define a
business
initiative

Assign it to a
group of
people

Divide into
tasks

Create, validate
and test
Decision Model

Approve
Decision
Model

Deploy
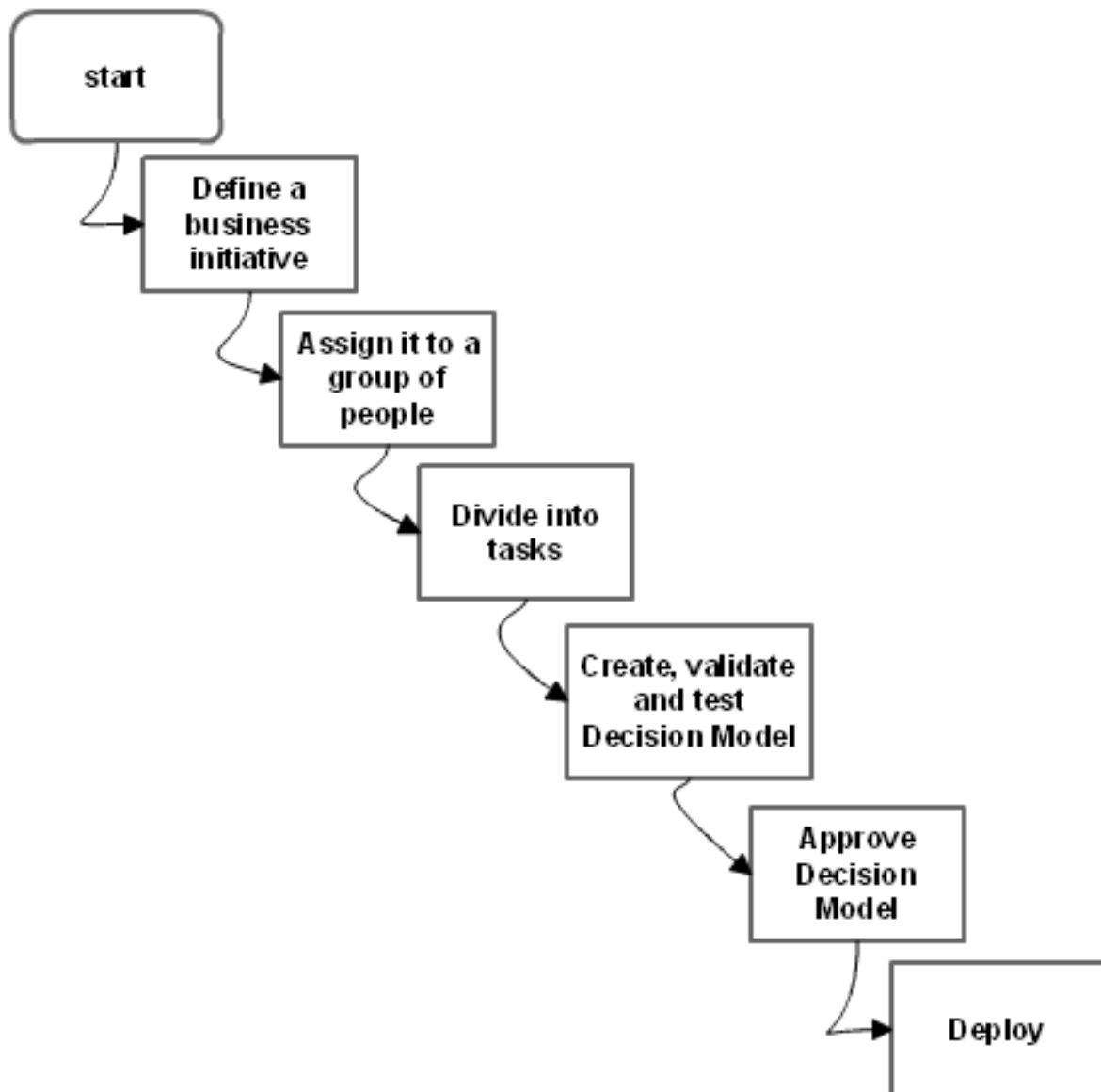
Figure 7: Simple Governance Work Flow
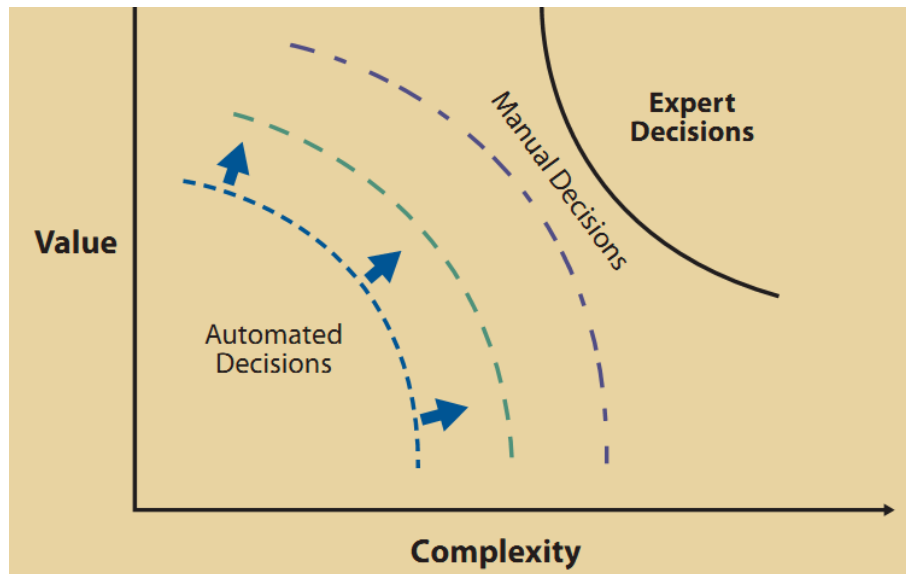
Figure 8: The best focus for EDM. Source: Taylor et al. (2011)

EDM works best with decisions of lower value and lower complexity. As shown in figure 8, improving technology is increasing the range of value and complexity that can be automated, squeezing the usefulness of manual, but non-expert decisions. When these lower value, lower complexity decisions must be made repetitively in high volumes, or when speed is critical, BDM practices are ideal and it is obvious that in this context their value and importance increases.

Moving further down the organization in the decision making process from management to operations, there are more people to train on policies or regulations, compliance becomes harder, and analytic skills become rarer. Decision management is focused on the automation of these decisions — either all the way to action or to the presentation of relevant, appropriate options. The policies, procedures, regulations, and best practices are captured inside the system, and information is not presented so much as used to drive the decision. So, while the decisions remain similar (operational, transactional, high-volume, front-line decisions) the new approach is quite different. The common factor that differentiates decision management is a ruthless focus on decisions. Decisions, and the identification and automation of them, are what make the different. Decision management begins with the decision in mind at all times and is focused on delivering the most precise, most consistent, most agile decision possible.

(Taylor and Raden, 2007)highlight the importance of operational decisions and the need to better manage them in "Smart Enough Systems Manifesto." They argue as follows:

- Operational decisions are an important foundation of the business. Organizations are perceived through the lens of the decisions they make. On a frequent time scale, lots of small decisions add up in the big picture. All decisions an organization makes, should be managed as though they are carefully calculated.

- With the available technology decisions can and should be automated, especially high-

volume, operational decisions. Traditional technology approaches, which are based on previous, more simple methodologies, will not succeed in automating decisions. The overall effectiveness of automated decisions must be measured, tracked, and improved over time.

- Taking control of operational decisions can be considered as a enabling source for improved performance (internal) and competitive advantage (external).

Thanks to the practices of decision management the business rules that capture decision logic (e.g., policies, regulatory requirements) no longer have to be hard-coded into business applications, with improvements visible in costs and time delays.

4.7.1 Effect

Because of the focus on operational decisions, BDM affects operational systems and operational processes. Many of these changes can be adopted seamlessly – an increased rate of straight-through processing, for instance, merely reduces the workload of those handling manual review. Although, sometimes the replacement of a manual decision with an automated one can be more disruptive. Groups that may have been used to referring every decision to managers may now have automation that empowers them directly, changing power structures. Staff used to spending time approving individual transactions may have to move towards a more analytic role as individual transactions are handled automatically. The following items provide a justification for BDM projects:

- Include human resources in the project to ensure that any changes to job descriptions, roles, and responsibilities are managed appropriately.

- Carefully evaluate the measures and bonus/commission structures used by those impacted by the new system to ensure they are incented to use it.

- Provide training and support for staff impacted by the application to ensure that a lack of understanding is not holding anyone back. (Taylor et al., 2011)

Operational and tactical decisions reward performance management because the time frames, and the time to respond, are much shorter, justifying the near-real-time supervision of results that's more typical of performance management.

4.8 The Decision Model

The Decision Model is a new way of looking at business logic. Instead of trying to manage the logic one business rule at a time, the Decision Model groups the rules into their natural logical groups to create the structure that make the model so simple to understand, communicate and manage.

(Halle and Goldberg, 2009b) define the Decision Model as an intellectual template for perceiving, organizing, and managing the business logic behind a business decision. It gives a specific form, function, and tangible visual representation to business logic as expressed by business people. The Decision Model results from the proposition that business logic has its own existence, independent of how executed, where executed, and whether or not it's implemented in an automated system. Taking this one step further, the Decision Model reveals that business logic, by itself, has a recognizable structure different from other model structures. Not only that, the Decision Model is distinct in its representation of business logic because a Decision Model aims to be:

- Simple to interpret and manage

- Declarative so as to be independent of technology or processing requirements

- Optimal in integrity due to a set of principles, meaning that its business logic is consistent within itself and aligns with business direction

As a separate model with these characteristics, the Decision Model elevates business logic to the status of a valuable organizational asset that would remain elusive without such a representation. The Decision Model must conform to a certain level of rigor if it is to serve as a starting point for all target technologies. That rigor is defined by the Decision Model's set of principles, and address the three most important qualities of a Decision Model: structural simplicity, declarative simplicity and optimal integrity (Halle and Goldberg, 2009a).

Many companies adopted a natural language approach to business rules, building rule expressions by a rigorous process to ensure the vocabulary of the rules are accurately aligned with the business and its enterprise glossary. Now organizations have the opportunity to reduce their costs and increase the quality of their business rules by adopting a new level of rigor where business rules are decomposed, normalized, analyzed, grouped and altogether connected.

To accomplish those qualities, the business logic is structured within the scope of a single business decision. There is a graphical representation and each decision consists of families of business rules. See subsection 4.8.1 for an example. The graphical representation abstracts the detail of the logic (business rules), but can be drilled into to view the rule families, which are decision tables (with rigorous principles) of the atomic business rules. The rule families are structures that allow for the analysis of the logic of the business rules to ensure their integrity. Decision tables are a precise yet compact way to model complicated logic. Each decision corresponds to a variable, relation or predicate whose possible values are listed among the condition alternatives. The Decision Model gives us a graphical way to view the rules at several levels of detail, and each decision is a connection point to our processes, 'process enabling' business rules, and simplifying processes. Experience with the Decision Model has indicated that business rule harvesting, maintenance and management has a significantly lower cost than traditional means. At the same time it promotes a higher level of business understanding of the rules, and simplifies business processes.(kpi USA, 2011)

	Conditions					Conclusion	
Rule Pattern	Person Employment History		Person Mortgage Situation		Person Miscellaneous Loans Assessment	Person Likelihood of Defaulting on a Loan	
1	Is	Poor	Is	Poor	Is	High	Is	High

Table 1: Rule Family example

The structure of the Decision Model lends itself best to implementation in a business rule management systems, because their production rule specifications have a close, if not one-to-one relationship, to the rows within a rule family. This leads to the highest conformance between the business logic statement and its technical implementation. (Halle and Goldberg, 2009a)

Practice indicates that the Decision Model makes it possible for nontechnical business people to interact intuitively with their own business logic. This leads to natural business governance over business directions and agility.

4.8.1 Example

Tabletable 1 is an example of a decision table, the first column contains the rule pattern, used for a set of rule family rows with a common set of condition cells, a useful feature in applying decision models. The table has one column heading 'Conditions', containing the name of the fact being tested and another heading 'Conclusion', containing the name of the conclusion to be reached. The rows below these column headings are populated using two cells for each label. The first cell is for an operator to apply against the column heading and the second cell is the operand for that operator. This way it is possible to convert each row in a rule family into a sentence that sounds natural to a business audience and is more precise and correct than the statement from which it is derived. This structure also enables the implementation of an understandable structure for computer systems. What is important is that the labels are named and defined correctly and the corresponding conditions and conclusions be expressed correctly.

Figure 9 shows an example of a decision model diagram, the business decision shown here is "Determine Policy Renewal Method". This diagram contains rule families as in the example above, it shows the structure of the business logic for making this decision and relates it to tasks within business process models and to steps within use cases, precisely at places in those models where the business decision is in play. The diagram contains six icons, representing the rule families. Obviously, there are (logical) dependencies among these groups as indicated by the lines connecting them. The name of each rule family is simply its conclusion column heading of the decision table. All labels below the rule family name are the condition
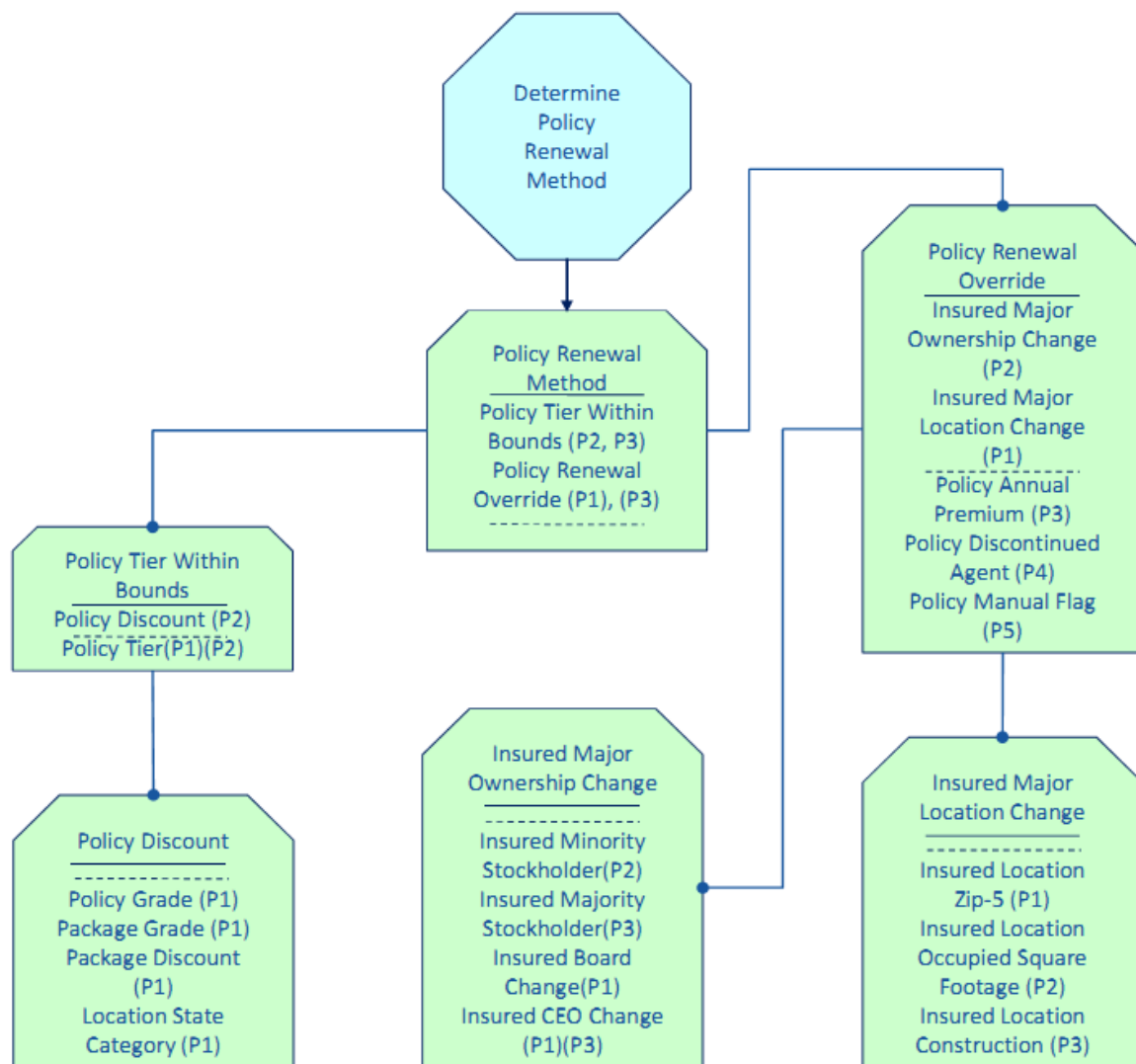
Figure 9: Decision model diagram. Source:Halle and Goldberg (2009a)

column headings that contribute to that conclusion. For example, the rule family 'Policy Renewal Method' in figure 9 has two conditions, one named 'Policy Tier Within Bounds' and the other named 'Policy Renewal Override'.

Decision Model normalization principles minimize redundancies and anomalies in the business logic. The template has the potential to change current business management practices and future technology and is emerging as a new business asset of high business value, enabling both business and IT professionals to rethink the way they view, design, execute, and govern business logic.

4.8.2   Decision Model Tools

In a traditional way Decision Models may be drawn with paper and pencil. However a more robust, digital solution is preferred, particularly when collaboration is high and the model is to be shared among many stakeholders. An electronic storage medium can be as simple as a MS Excel spreadsheet containing the rule families and Decision Models. But at heavy use, these options fail to provide adequate support as the quantity and complexity of the business logic grows. These options are also inadequate as changes in business logic increase. Therefore, other than pilot or small projects, more sophisticated decision modeling tools are needed. An array of such tools, each aimed at a different level of modeler, is expected in the future as the practice of BDM matures across industries. Insights and examples are discussed in the following subsections. (Halle and Goldberg, 2009a)

Analyst Tools   Business analysts are most often the people who capture business logic and business rules and create Decision Models for a particular project. Analysts often do so use spreadsheets, documents, or requirements tools, but in many cases the better alternative is a tool where rule families can be defined and more context than just a list of items is available. As seen in section4.8, a rule family contains a table with multiple columns and rows. Each row is a logic statement (or business rule) that can be separately maintained. The tool should have features for maintaining the glossary of fact types, and other metadata that is important to the business logic, such as version, status, and business motivation.

In the particular case for the Decision Model, as defined by (Halle and Goldberg, 2009a), a business analyst can create a Decision Model diagram using a diagramming tool such as Microsoft Visio, but such a diagram lacks rule family content and metadata. Therefore, the business analyst should be provided with a tool to enter rule families in order to better manage the content and add relevant metadata. The advantage of emerging tools like this for business analysts is that they deliver functionality specific to the Decision Model and rule families. The use of these tools is superior to paper and pencil, an extensions to requirements tools and a leverage in the use of spreadsheets. Further on in the research under The OpenRules® platform, we will take a look at the capabilities and functionality of the OpenRules platform if tools like these are useful.

Business People Tools   There are tools that enable a person who is neither a business analyst nor a technical person to create simple models and simple business requirements, probably for a particular project. Using one of these tools, a business person can create a simple business process model and a set of requirements using an interface much like that of Microsoft Visio and Microsoft Excel. However, such tools would lack the ability to provide sophisticated modeling, requirements capabilities or store extended metadata. The purpose of better tools is to enable a business person to initiate the creation of business process models, including

corresponding requirements, and ideally, Decision Models. Once the information is available in these tools, such artifacts can be passed onto business analysts, enterprise architects, or technical people, who improve them with technical considerations. It is expected that requirements tools will also be Decision Model enabled. It would enable a functional requirement in the requirements tool that is implemented by a Decision Model to be traced to the relevant Decision Model. Decision Models could either be created within the requirements tool, or provided via an external tool.

At the time of this writing, such tools for business people are just emerging, so functional details are not very well documented. RuleGuide is a step in this direction, and it will be interesting to see if the product evolves to fulfill this promise. The advantages of software tools for business people are that these people can drive the creation and management of Decision Models, at least up to a certain point. They can do so with minimal reliance on a business analyst or technical support. (Halle and Goldberg, 2009a)

Future A vision arises for a full spectrum of Decision Modeling enabled software. Ideally, the creation of business logic in Decision Models is initiated by business people using a very simple and intuitive modeling tool. Such a tool supports only what pure business people want to capture about their business process models, Decision Models, and rule family content. From here, rule family content is shared with a more sophisticated tool for use by business analysts, who manage the content regarding versions, stewardship, and perhaps automated analysis, usually on behalf of one project. Afterward the Decision Models and rule family content are shared with a requirements tool, or a sophisticated tool for use by enterprise architects. Within this tool, the Decision Models and rule families are connected to other related artifacts, including the generation of executable code, perhaps for a project or for the enterprise. Comparisons to and integration with enterprise artifacts are possible. Such a tool provides support for translating business process models and Decision Models into deliverables for SOA. (Halle and Goldberg, 2009a)

4.9 Results

When companies use decision management to reduce the complexity of their business processes and improve agility, the results can be dramatic. For example, a truck manufacturer had a warranty claims process that took one week thanks to the complexity of the warranty arrangements with suppliers. Replacing this manual process with one based on a BPMS, BDM and BRMS reduced the time to process a claim from one week to just 6 hours. Other companies have achieved similarly impressive results:

- 99% auto adjudication of claims (up from 20%)

- 50% reductions in managerial oversight

- Error-free daily updates to pricing rules

- 95% automation of pension fund update requests

- 98% reduction in time to implement regulations

Source: (Taylor, 2011b)

4.10 Summary

The integration – in design, implementation, management and governance – provides the necessary foundation for an enterprise to truly focus on its business and recognize its decisions as true corporate assets.

- Managing decision logic for transparency and agility

- Embedding predictive analytics for analytic decision-making

- Optimizing results given real-world trade-offs and simulating results

- Monitoring and improving decision-making over time

Companies adopting decision management use what is called 'decision discovery' to find the decisions that matter to their business and drive the results they seek

The structure of the Decision Model lends itself best to implementation in a business rule management systems, because their production rule specifications have a close, if not one-to-one relationship, to the rows within a rule family. The Decision Model has the potential to change current business management practices and enabling both business and IT professionals to rethink the way they view, design, execute, and govern business logic.

5 BPM

In this chapter will highlight the context of business process modeling (BPM) in which rules and decisions are used. A rules-driven business process model system (BPMS) uses business rule engine technology to drive the business process. The system allows a business analyst to model the process and automate human tasks by defining the business rules to be applied, rather than wait for a developer to code the logic of the task. This bridges the gap between business and IT, enabling each group to do what they do best, which in turn reduces costs, improves productivity and accelerates time-to-value. As the value of rules-driven process management becomes more well-known, the push to include it in all solutions is becoming stronger. According to reports from Gartner, Forrester and Delphi, customers are listing business rules capabilities as a "must-have" feature for any process management technology under consideration. (Minsky, 2005)

BPM empowers a business to align IT systems with strategic goals by creating well-defined enterprise business processes, monitoring their performance, and optimizing for greater operational efficiencies. These tasks can be implemented as services within the enterprise. The BPM system provides a toolset that allows the business analyst to create process models using notations such as BPMN, and then performs the business process automation, or execution of the model, by invoking the services. Additionally, the BPM system provides monitoring and management capabilities. (Rosen et al., 2008)

One major complication is that enterprises want to leverage their existing systems and include them into the new business processes. Unfortunately, enterprises have tremendously complex IT environments that have evolved, often over several decades, using different platforms, different technologies, and different communication standards. This is a problem that enterprises have struggled with for years through a string of promising (or overpromised) technologies. The systems has evolved into a complex environment, not easy to manage or change.

5.1 Decision Integration

5.1.1 Decision-aware Business Processes

(Halle and Goldberg, 2009a) define a decision-aware business process as one that is designed to distinguish between tasks that perform work (i.e., process tasks) and tasks that come to conclusions based on business logic (i.e., decision tasks). Because a decision-aware business process makes this distinction, the details behind a decision task are separated from the details behind the process task. This separation enables the details behind a decision task (i.e., business logic) to be represented in a different kind of model, specific to business logic. However, most business processes today are not designed to be decision aware.(Taylor and Raden, 2007) describe the problem as follows: "Although organizations have automated standard processes with enterprise software, these operational decisions haven't been the focus

of investment. They are overwhelmingly made manually or automated poorly, which is a mistake. Embedding business processes in systems to streamline operations but not managing and improving these decisions leaves half the opportunities for improvement untouched."

To manage and improve business decisions (declarative), they need to be separated from the business processes (procedural) that rely on them. To separate business processes and business decisions, they must somehow be different from each other in a recognizable way. It turns out that they are truly different in a very significant way. In fact, the inherent nature of a business process is very different from that of a business decision. To date, however, this difference has not been well understood, but the advent of the Decision Model brings this difference to the forefront. A more detailed view on this topic has already been addressed in the previous chapter 4.8 on page 40. Now we will take a look at how processes can be changed and re-engineered to a better structure and to include those business decisions.

5.1.2 Externalization Example

A typical first implementation of a BRMS starts by creating the business logic. The team has selected a BRMS as part of a project and they start capturing their rules using a software package (see also 3.3.1 on page 24). Typically they interview experts, read policy manuals and reverse engineer code into rules. Almost always, but especially when they reverse engineer code, they end up with a lot of fairly low-level rules. In one, big, bucket. This big bucket of rules is not usable. The team will often try to add rules to their very complex process diagrams - placing each individual rule on the process diagram. Most of the low level rules cannot be placed in this way and doing so just contributes to over-complex business processes. It's also difficult to manage the rules properly. There's no organizational structure to the rules so they end up being grouped by source or by the person responsible for the rule identification. As policies or regulations change, or as new business needs are identified, the team often struggles to update the business rules in a correct way.

The Decision Model can bring structure and simplicity as, the the team typically perseveres and ends up grouping the rules into services that perform some useful action, typically answering some question or selecting an action from a list of candidate actions. Groups of rules, rulesets and the rule families are deployed as services or several rules are linked together and deployed. These services can be invoked as decision services by existing systems or as part of a new business process.

What the team has done, often without realizing it, is identify the decisions that their rules support. Not only are these decisions more stable - new decisions within a business are seldsome while new rules or changed rules are common - they represent the connection point that existing systems and new processes need. Connecting systems and processes to decisions and making those decisions using rules gets them the results they were looking for. They get a positive ROI from using a BRMS by making these decisions more accurately and more con-

sistently. They engage business users and empower them to manage the rules. They deliver agility as it is easier to evolve the rules behind these decisions as the business changes.

However a problem can arise as the decisions being managed using these business rules are not central to the solution. If the team does not have a way to identify and classify decisions that are suitable for automation with a BRMS then the BRMS will be perceived as a solution to the first, specific problem for which it was purchased. Similarly, without a way to identify high priority decisions and so focus expansion efforts on the rules needed for them, broad based adoption of the BRMS will often stall.

A part of BDM resolves these issues. BRMS generate an ROI when they improve business decisions - it are those decisions that create the highest value. By focusing on the decisions that matter to the organization, the ones that affect the business drivers and measures, decision management simplifies business rules design and implementation while accelerating adoption of a BRMS where it has the highest impact.

Decision management is a proven framework that ties business rules to business objectives and KPI's. A BDM approach to business rules begins by looking at business performance drivers, identifying the decisions that are impacting them, then analyzing what decisions will have the biggest return. By focusing on decisions, decision management streamlines BRMS implementations into the processes, ensures business ownership of the business rules, and delivers agility and continuous improvement of decisions across the company (Taylor, 2011a).

5.2 Business Process Reengineering

Business process re-engineering (BPR) is the analysis and design of work flows and processes within an organization. It is also known as business process redesign, business transformation, or business process change management. Business process re-engineering (BPR) began as a private sector technique to help organizations fundamentally rethink how they do their work in order to dramatically improve customer service, cut operational costs, and become world-class competitors. A key stimulus for re-engineering has been the continuing development and deployment of sophisticated information systems and networks. Leading organizations are becoming bolder in using this technology to support innovative business processes, rather than refining current ways of doing work. (Brock and Finedore, 1997) Here we will address the application of process re-engineering further on to demonstrate the use of decisions and their integration into the business processes.

The used approach in the previous section were decisions are separated, creates more simple and productive processes, supported by a consistent business logic. The separation prevents that business logic is buried inside the business processes and visa versa a business processes cannot reveal all business logic. Re-engineering the process describes tasks in a prescribed sequence as part of the procedure, differentiating those tasks representing a conclusion carried out by the declaration and analysis of the business logic.

The best practice for centralizing business rules and decision is a well-defined and managed business logic, this way decisions can be externalized in an robust way. Once identified, operational decisions are the best candidates for externalization, as concluded before. This means to remove code from other systems that implements them – untangle them – and explicitly identify them as decision services. Finally to separate them so they can be enhanced, managed, and used across the organization. The advantage becomes a simplified maintenance and reduction in the total cost of maintenance (Taylor et al., 2011).

Enterprises adopt their business processes to achieve operational excellence, the synopsis of which translates into the lowest possible cost of providing a given level of service, the latter preferable high. This is a valuable goal, but for the truly competitive organization often insufficient. After all, erasing most of the inefficiency out of a business process is a tactical resource available to all players in the market. A competitor who achieves or exceeds the same level of efficiency will over time, inevitably challenge the most efficient operator, all other things being equal. The key differentiation in delivering value becomes the organizational intelligence that is applied in the management of those critical business processes.

In short, advantage and operation excellence is not only about how efficient a business process is, but also how smart it's business decisions are. Implementing a business process correctly is as much and perhaps more about managing business decisions as it is about business processes. By ensuring that an enterprise pays attention to both sides of this dependent relationship, the business is more likely to achieve the greatest gains from process improvement. Further on a number of benefits are stated, resulting from process re-engineering and decision externalization.

5.3   Smart Business Processes

The most important and key business processes must not only be efficient and consumer-friendly, they must also be smart and agile. Business processes become agile when declarative business decisions are separated from procedural business process tasks. Secondly, business processes become smart when the business decisions are governed appropriately by business leaders. Business decision governance involves monitoring the business decision performance against objectives and recognizing when events occur that raise the operative context of a business decision into the complicated, complex, or chaotic realm. When the business leadership clearly understands the business logic behind the business decisions, the impact of those decisions can be revealed, and the business can quickly and easily make adjustments. This approach make the decisions smart and servant as intelligent business levers. (Halle and Goldberg, 2009a)
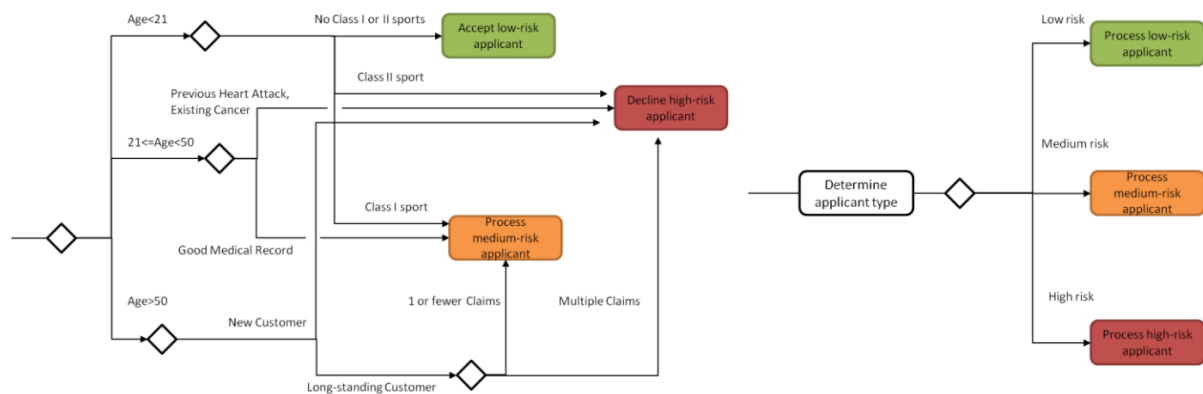
Figure 10: Simplifying process by externalizing decisions. Source: (Taylor, 2011b)

Decrease process complexity

Making decisions explicit and managing them in harmony with processes ensures an effective separation of concerns and a more streamlined business. Combining business process management and decision management will decrease process complexity and increase straight-through processing (STP) (See figure 10). Decision Management marries explicit decisions and process management to keep transactions moving with only exceptions ending up on work lists or in an inbox.

Separating business decisions from business process tasks simplifies the business process model, offers more creativity in organizing the business logic, and delivers the business logic in a form that goes past technology options as also will be seen in subsection 4.8. Solutions become less sophisticated, resulting in smaller amount of steps or processes for a certain goal. Additionally, business process models can be reused, resulting in more generic models. The delivered value of this practice is twofold; where improvements in business process aim for increased work efficiency, improvements in a business decision aim and create a smarter business logic.

Extracting the decision and putting it 'first' creates a dynamic process - one driven by the specific customer, case or transaction - without increasing process complexity as dynamic processes can be overly complex with multiple paths and complex routing.

Flexibility

The externalization of rules gives us similar flexibility in two areas. Consider for example the service that decides whether or not to underwrite a particular policy. If the rules for policy risk change, the changes are isolated in the lower-level risk decision service and don't affect the implementation of the underwriting service as a whole. Or, perhaps underwriting automobile insurance for commercial customers uses different rules than for individual customers. We could potentially use the same service for both types of customers by configuring the underwriting

service to use a different risk decision service. Again, the example may seem trivial. Why not just put a conditional statement into the code? Wouldn't that be easier? Easier, yes; better, no. What happens when we add a third or fourth type of customer with a different risk profile? Simple, just change the configuration, not the code. (Halle and Goldberg, 2009a)

Increase agility and engagement

Process management software is very liked by business users; it allows them to change their work flow easily. BDM takes this flexibility to another level, because business changes often involve changes to decisions in the company - for example decisions in pricing, eligibility or risk assessment. Decision management allows the business users to control their processes and the critical decisions within them. Explicitly identifying decisions and describing the logic behind them allows this logic to be managed and updated separately from the process itself. Process changes do not have to be made, when changes in decisions, due to different circumstances, are made, dramatically increasing the agility of an organization.(Taylor, 2011b)

The increase in an organization's agility is also due to the degree of business-IT collaboration in business processes. Explicitly modeling the decisions that happen in the business process ensures that the 'as-is' model is closer to reality. Decision management clarifies the behavior of the process, makes it easier to see if the process or the decision must change, and allows for changes in the decision-making approach to be independent from process change.

Opportunities to apply analytics

The power of analytics lies in making better decisions as information about previous decisions is gathered and used to make better decisions in the future. BDM allows analytics to be applied to data including process execution and external data about customer behavior. Advanced decisioning puts these analytics to work embedding more precise, more profitable decisions in the business processes. Instead of reacting to events, analytics enable pro-active decision making before any unwanted errors occur or wrong decisions would be made (DecisionManagementSolutions, 2009).

5.4   Business Decision Maturity Model

It is easy for a complex process to result in deliverables of poor or inconsistent quality. This is especially true when the process is not well defined, well communicated, well learned, or appropriately evaluated for quality. Here a model is introduced to provide guidance for those processes.

(Halle and Goldberg, 2009a) propose the use of a business decision maturity model (BDMM). The significance of the change introduced due to the model and the value to the business

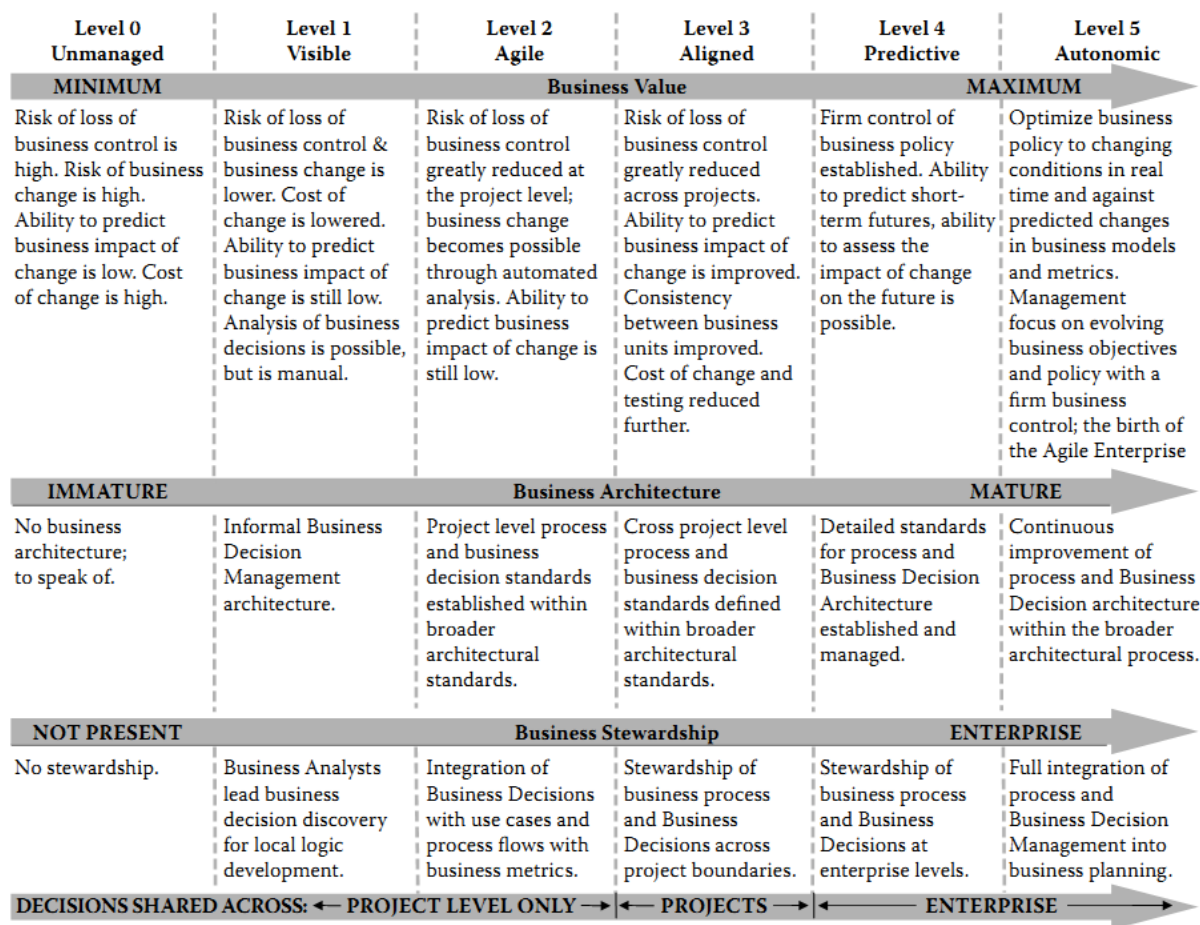| Level 0 Unmanaged	Level 1 Visible	Level 2 Agile	Level 3 Aligned	Level 4 Predictive	Level 5 Autonomic
MINIMUM		**Business Value**			**MAXIMUM**
Risk of loss of business control is high. Risk of business change is high. Ability to predict business impact of change is low. Cost of change is high.	Risk of loss of business control & business change is lower. Cost of change is lowered. Ability to predict business impact of change is still low. Analysis of business decisions is possible, but is manual.	Risk of loss of business control greatly reduced at the project level; business change becomes possible through automated analysis. Ability to predict business impact of change is still low.	Risk of loss of business control greatly reduced across projects. Ability to predict business impact of change is improved. Consistency between business units improved. Cost of change and testing reduced further.	Firm control of business policy established. Ability to predict short-term futures, ability to assess the impact of change on the future is possible.	Optimize business policy to changing conditions in real time and against predicted changes in business models and metrics. Management focus on evolving business objectives and policy with a firm business control; the birth of the Agile Enterprise
IMMATURE		**Business Architecture**			**MATURE**
No business architecture; to speak of.	Informal Business Decision Management architecture.	Project level process and business decision standards established within broader architectural standards.	Cross project level process and business decision standards defined within broader architectural standards.	Detailed standards for process and Business Decision Architecture established and managed.	Continuous improvement of process and Business Decision architecture within the broader architectural process.
NOT PRESENT		**Business Stewardship**			**ENTERPRISE**
No stewardship.	Business Analysts lead business decision discovery for local logic development.	Integration of Business Decisions with use cases and process flows with business metrics.	Stewardship of business process and Business Decisions across project boundaries.	Stewardship of business process and Business Decisions at enterprise levels.	Full integration of process and Business Decision Management into business planning.
DECISIONS SHARED ACROSS: ← **PROJECT LEVEL ONLY** →			← **PROJECTS** →	←	**ENTERPRISE** →

Figure 11: The Business Decision Maturity Model. Source: Halle and Goldberg (2009a)

means introducing new roles, new deliverables, new skills, and new technology into progressive organizations. Figure 11 shows the details for the BDMM, for each level it states the level of business value, business architecture and business stewardship. Although it has to be noted that the BDMM doesn't measure effectiveness of the modeling itself, it measures the business decision modeling process.

(Halle and Goldberg, 2009a) state that early experience with the Decision Model confirms that the business decision and Decision Model are assets that gain higher business management attention. As such, it is easier to incorporate them earlier in business-driven projects, such as BPM, process improvements, and business transformation efforts. Business people easily recognize that business value is not found in the individual business rule or business logic statement, but rather in entire business decisions, thereby using entire Decision Models as driving assets to support business objectives. At the same time, the natural connections from the Decision Model to the BDMM, BPM and SOA are so compelling that they elevate the management of business decisions to the status of critical technology assets or services.

The impact of decision management on business, information technology is significant

enough to develop a maturity model focused on business decisions. A good way to gain maturity in process creation, is to define and follow a maturity model focused on the process of managing business decisions. The BDMM can be used by organizations to determine the maturity level they are at, the level they need to achieve, and a plan for doing so.

5.5 Summary

BPM empowers a business to align IT systems with strategic goals by creating well-defined enterprise business processes, monitoring their performance, and optimizing for greater operational efficiencies. As the value of rules-driven process management becomes more well-known, the push to include it in many solutions is becoming stronger. The goal is to create smart business processes. First, by separating declarative business decisions from procedural business process tasks and second, when the business decisions are governed appropriately by business leaders. The key differentiation in delivering value becomes the organizational intelligence that is applied in the management of those critical business processes. A good way to gain maturity in process creation, is to define and follow a maturity model like the BDMM.

6 SOA

As we have seen in the preface, knowledge management is achieved through the combination of decision management, business process management and now here the third part is discussed, the service-oriented architecture. SOA is the third technology used in the goal to encapsulate business knowledge in services and to create optimal operational and automated decisions for the organization in the process of knowledge automation. This chapter will provide an introduction to decision services and the concept of a service-oriented architecture. The OpenRules platform tries to be a "good citizen" of the modern service-oriented world as they approach a SOA with rules-based decision services. A detailed look into the OpenRules platform can be found in the next chapter, more particularly in section 7.3 on page 79.

6.1 What is SOA?

6.1.1 Business Context

First, take a look at the business context of service orientation, a means for building distributed systems. At its most abstract, service orientation views everything - from the mainframe application to the printer to the insurance salesman to the overnight delivery company - as a service provider. Service providers expose capabilities through interfaces. SOA maps these capabilities and interfaces so they can be orchestrated into processes. The service model is "fractal" as the newly formed process is a service itself exposing a new, aggregated capability.

Fundamental to the service model is the separation between the interface and the implementation. The invoker of a service need only and should only understand the interface. The implementation can evolve over time, without disturbing the clients of the service. Interestingly, the same interface can be offered by many implementations, several key benefits of service orientation derive from this abstraction of the capability from how the capability is delivered. (Burner, 2004)

6.1.2 Service Orientation

A very good analogy is an egg. Presented with an egg, a farmer might envision a chick, a cook might envision an omelet, and a child might envision a brightly painted Easter decoration. Service orientation is an egg. Every one involved has a different view and expectations.

To developers and solution architects, service orientation is a way for creating dynamic collaborative applications. At run-time it allows applications to be sensitive to the content and context of a specific business process, and to gracefully incorporate new capability providers over time.

To the IT manager, service orientation is a means for effectively integrating the diverse systems in an organization. The target is to provide a model for combining the information

and business logic of multiple systems into a single, coherent interface, including integration for redundant or a systems.

To the business analyst, service orientation is a means of bringing information technology investments more in line with business strategy. By mapping people and skills, external capability providers, and automation systems into a single model, the analyst can better understand the cost tradeoffs associated with investments in people, systems, and sourcing.

Driven by the need to achieve greater insight into business activities, the enterprise IT departments including the roles described above, are seeking effective and appropriate means to integrate their application portfolios. The main goals are transparency and coherency. To achieve transparency and coherency, organizations must create connections.

They must connect systems to create consistent management of information. They must connect human and technical capabilities to create consistent business processes. They must connect staff workers to create collaborative teams and they must connect organizations to create effective value chains. Hereby the challenge lies in connecting diverse systems is the translation of platform-specific information and procedural models. (Burner, 2004)

6.1.3 Definition

(Rosen et al., 2008) define a service as "A discrete unit of business functionality that is made available through a service contract." or "A loosely-coupled architecture designed to meet the business needs of the organization." (Microsoft, 2012)

By definition and by name, SOA is a kind of architecture. Therefore, as an architecture, SOA implies the construction of something that results from (or seems to result from) controlled thought, not a random outcome or one left to chance. A complete architecture envisions the final constructed product from a broad perspective as well as the details (like the interface, documents, policies, quality and performance) necessary for every aspect of it. It is an architecture that applies to the construction of automated systems, as an architecture which is service-oriented, SOA implies the construction of (automated) services in an orderly, not random manner.

The important point is that how the service is implemented, is not visible to the consumers of the service, only what the service does, the interface is visible. The producer of a service is free to change the implementation of a service, as long as it does not change the behavior of the service. This definition does not indicate how many services an enterprise needs to acknowledge or that there are services playing different roles, having different sizes, and living in different layers of the architecture. Determining those details is what SOA is all about. However, the most important characteristics of SOA are its broad perspective, for example services uses across the whole organization in trying to achieve better alignment and maturity in the company, and its details, i.e., the inventory and management of the organized services.

6.2 Importance

SOA's enterprise view is what makes it strategic today. (Rosen et al., 2008) state that SOA represents a better, more modular, flexible way to build enterprise solutions for business processes. Aimed at the enterprise level, SOA has the potential to deliver significant business value, more specific in the following areas:

- Consistency: SOA enables a single, common entry point into a business process, task, or business decision via it's interface.

- Commonality: SOA enables a single point of access to common information.

- Modularity and flexibility: SOA enables an excellent mechanism for implementing modules of business functions, business decision, and information.

- Decoupling: SOA enables a means for integrating business functions and information while minimizing dependencies among them.

- Manageability: SOA enables the management of the business by service level agreements (SLA's) at the modular level.

There is no doubt that SOA is destined to be the architecture for the next decade, just as Web-based architectures predominated application development during the 2000s. All major software platforms and products are moving toward an SOA-based infrastructure built on top of an application and integration server platform in combination with BPM capabilities. In addition, major application vendors are spending billions of dollars to reengineer their product suites into collections of discrete services, tied together by processes and executing on an SOA platform. Finally, the explosion of Software as a Service (SaaS) offerings is further fueling the hype and adoption of SOA. SOA provides a better, more modular, and more flexible way to build enterprise solutions, and especially to support business processes.

6.3 Decision Services

Decision services are the implementation of a decision, the catalysator – how systems will find out what the best or most appropriate decision is for a particular customer or transaction, according to the business rules set. A decision service also makes the decision reusable and widely available. Decision services are usually composed into larger services and are small to medium in size.

Essentially decision services are business services in a SOA that deliver an answer to a specific question. Services with a decision role generally provide yes/no answers to complex questions, or support frequently changing externalized rules, such as tax regulations. Generally these services do not update information – they just answer questions such as "How should we handle this claim?" or "What is the right discount for this order?". Because they don't
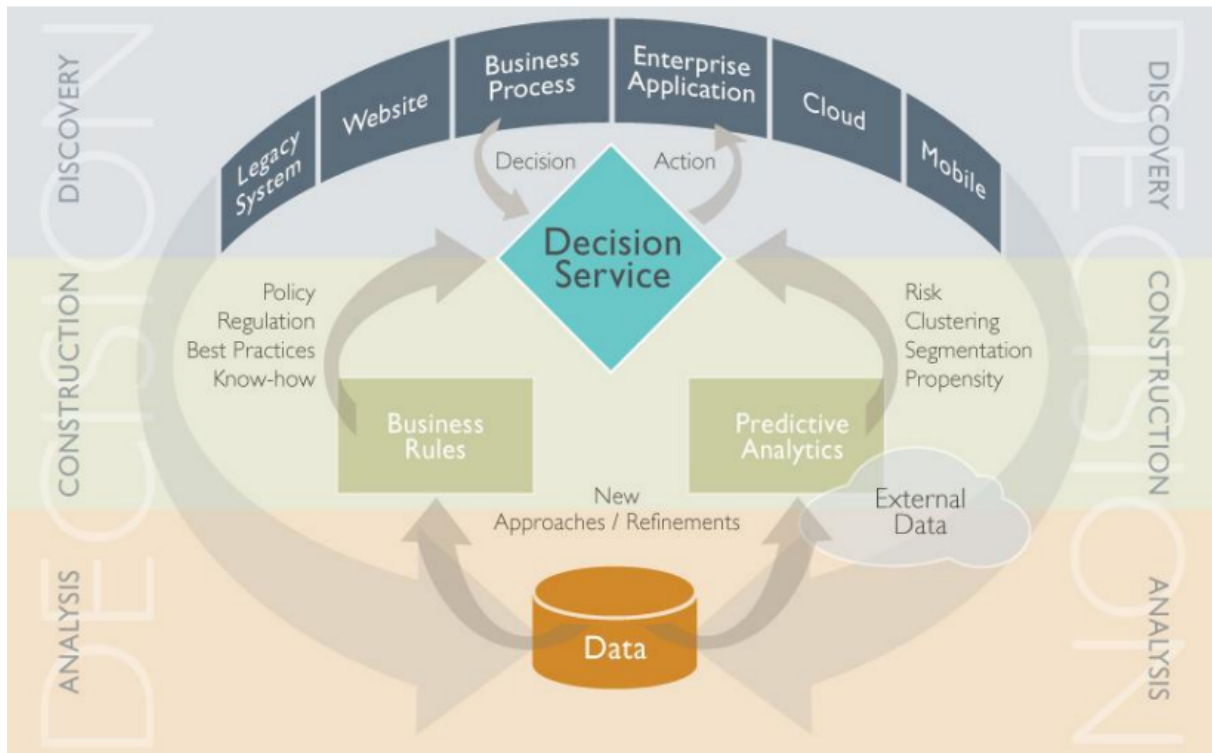
Figure 12: Decision Services at the center of the application portfolio. Source: (Taylor, 2011a)

make any permanent changes, they can be used to answer questions whenever they come up without worrying about potential side effects. Decision services are built primarily using business rules managed in a BRMS, sets of rules executed to provide a conclusion and so the business decisions. The rules are the core building blocks of Decision Services as they help to create a language the business and IT can both understand, essential for effective decision management. While many only need a BRMS, they also support the integration of data mining and predictive analytics in the present or in the future. Best practices provide a variety of patterns, techniques, and tools for service composition that help us reduce dependencies, limit coupling, and maximize flexibility. Figure 12 shows how all these elements come together to provide the services across an application portfolio.(Taylor, 2011a)

The tasks of the business processes are implemented by services; high-level task-focused business services are composed of other, smaller services. This approach can create new and different compositions of services using the richer set of process, entity, and decision service usage roles in combination with the benefits of flexible, changeable rules, along with the benefits of modularity, flexibility, and reuse of the SOA.

With a common SOA-based architecture for decisioning applications across the services user life cycle, IT can speed implementations and upgrades, simplify maintenance and training, and gain more efficiency and value from data, technology and analytic insights. The services-oriented approach makes it easier to integrate third-party software with BDM applications and

enables IT to avoid the costly prospect of "ripping and replacing" legacy systems. Instead, adjunct decisioning services can be used with these core systems, enabling them to continue to operate and produce ROI in today's world of real-time analytics-driven customer interactions. (FICO Corporation, 2009)

Although SOA will happen regardless, significant additional value from SOA is realized when services are reused across multiple business processes. Many enterprises and projects will not succeed with significant reuse of their own custom services. There are many reasons for this; among them are the lack of architecture in IT organizations and a lack of understanding of the relationship between services, decisions, and processes. (Halle and Goldberg, 2009a)

Flexible Service Design

SOA often needs to span many or a lot of processes and can cause difficulties in service design. Service designers want to avoid overlaps in function between services, avoid gaps in function between services, avoid duplication of data and coordinate access to it and have a single, consistent way of performing a given function. A key to achieving these goals is to keep the following questions in mind during the design of a service:

- Who is responsible for a given function? Where is that function used?

- Who is responsible for management of specific data?

- Who is responsible for defining and implementing specific rules?

- What step in the process owns the specific knowledge needed to perform a given task?

The answer to these questions it helps to identify what the service should do and what it is responsible for. Just as importantly, it identifies what the service should not do, but rather depend on other services for.(Rosen et al., 2008)

Think about some of the issues in reusing services, as probably not every consumer of a service has the same configuration and is subject to the same business rules, has the same level of authorization and entitlement or needs the same service level. The best approach for flexible service design is use the time-proven technique of indirection, or externalization. Rather than having these things hard-coded in the service itself, we design the service to get the information remotely at the appropriate time. (Rosen, 2008)In the next subsection, section 6.4it will be clear that the Decision Model structure is a suitable technique that support flexible service design and reuseability.

Example

Say, you have a decision service for insurance policy issuance. Among other things, to issue the policy, the service must update information about the customer, make a decision about

underwriting, create the policy, bill the customer, and so on. The policy issuance service coordinates all of these activities and then uses other services to help accomplish the processing. So, obviously, the policy issuance service is dependent on (coupled to) the customer service, underwriting service, policy service, and billing service. This is normal. So why don't just implement all of these capabilities directly in the issuance services? For two reasons: The first is to be able to reuse the underlying capabilities in other high-level processes or services. The second is that policy issuance is not responsible for managing the customer, making underwriting decisions, managing the policy, or billing. It needs to use them, but it is not responsible for implementing them.

This way the customer service can be reused in every place that needs to access customer data. But more important than the reuse of code is the isolation/centralization of access to customer information. Because there is only one way to access the data, the data is always consistent. So, although there are many services (order processing, billing, etc.) that are dependent on the customer service, this kind of dependency is understood and managed through the use of patterns.(Halle and Goldberg, 2009a)

6.4   SOA and the Decision Model

Obviously, a primary focus when developing an enterprise's SOA is the creation of the service inventory. It is also important for the service inventory to be useful for and understandable by both business people and IT professionals. The Decision Model provides a starting point from which to create an inventory of services for the business logic. That's because each Decision Model has a well-defined scope and can be measured not only for technical performance but for its impact on business performance.

Services can be at a very fine-grained or coarse-grained level. A Decision Model has granular pieces - from single instances in a rule family to a rule pattern to an entire rule family to a partial or entire Decision Model. Because the core unit of reuse in a Decision Model is essentially the rule family, each rule family is potentially, as the lowest granular component, a stand-alone decision service. A composite decision service may be constructed by composing together the rule family services of the rule family dependencies that together make the particular decision service. At the coarse level, multiple decision services can be used in a task service composed of many different services. Determination of the appropriate inventory of such composite services should be based on size, stewardship, volatility, and reusability of Decision Models as a starting point. (Halle and Goldberg, 2009a)

Once there is a preliminary inventory of composite services, it can be cross-referenced to Decision Models to understand and confirm the enterprise need for decision services. That is, such a cross-reference reveals the opportunity for sharing decision services, thereby providing useful input to the identification of shared services. The concept of such a matrix is shown in 13. The input to a decision service developed from a Decision Model includes a set of values for

Candidate Task Services	Business Decisions (Decision Models)				
	Claim Decisions			Policy Decisions	
	Decision Model 1	Decision Model 2	Decision Model 3	Decision Model 4	Decision Model 5
Service A	X	X	X		
Service B		X	X		
Service C	X	X	X		
Service D		X	X		X
Service E	X			X	X

Figure 13: Matrix demonstrating re-use of business decisions. Source: (Halle and Goldberg, 2009a)

all fact types in those Decision Models for which there are no inferential relationships to other Rule Families. Simply put, the only input a Decision Model needs is a set of values for all fact types whose values are not the conclusion from another rule family. The output from a Decision Model is the conclusion fact type of the decision rule family. In other words, the interface to the potential decision service is rigorously defined by the Decision Model.

In figure13, Decision Models 2 and 3 appear to be of interest to most of the candidate task services, whereas Decision Model 4 is relevant only to one. At the very least, this points out that the design and delivery of the decision services for Decision Models 2 and 3 need to consider their wide enterprise usage.

Regardless, most services (other than fine-grained task or entity services) are likely to contain a business logic aspect. It is important that business logic be separated in a manner enabling it to be defined and managed by the business. Therefore, services should always be built with the business logic organized into a Decision Model and separated into a separate service, even if the decision service is never used in a stand-alone mode. (Halle and Goldberg, 2009a)

6.4.1   Integrating BPM and SOA

SOA goes well beyond the details of connectivity or interface technologies to get to the "what," not the "how" of services. SOA is about enabling the independent construction of business-aligned services that can be combined into meaningful, higher-level business processes and solutions within the context of the enterprise. The challenge of SOA is not creating a service, it is about enabling the enterprise to build the right collection of services. The real value of SOA comes when reusable services are composed together to create agile, flexible, business

processes. Unfortunately, that does not just happen by itself. (Halle and Goldberg, 2009a)

In order for the composition of services to actually result in meaningful business processes, all of the services that are composed together need to share a variety of important characteristics. This requires that the architecture specify those important characteristics, including how services

- Have similar size, shape, form, function, and other characteristics

- Conform to enterprise standards

- Communicate at a technical level

- Communicate at a semantic level

- Support enterprise goals and strategy

BPM is an example of separating out the work flow or schema of a business process from the rest of the logic so that the work flow can be executed and managed in a specialized environment, and so that the business can rapidly respond to changes by quickly modeling new processes. SOA facilitates this by providing business services as the basic building block of business processes. Similarly, BDM or BRMS is an example of separating out business rules or decisions from the rest of the application logic so that the rules and decisions can be executed and managed in a specialized environment and can easily be changed to support new business requirements. Again, SOA facilitates this by providing services that expose business rules and decisions. (Halle and Goldberg, 2009a)

6.4.2 Layered SOA Architecture

BPM provides a wonderful abstraction for building business systems. But all too often, we see BPM being used to build higher-level, more efficient, but nonetheless siloed applications rather than contributing to an overall flexible, agile enterprise. This is where rules, decisions, and SOA come in. BDM allow us to separate out business rules and decisions from a particular process so that the rule or decision can be applied consistently across multiple processes, and so that it can be easily managed and modified. SOA provides the application platform to host business decisions, and bridges between the business processes, the decision, and the operational resources, as shown in the following figure 14.

Together, BPM and SOA provide a good combination for service and process management. BPM provides the higher-level abstraction for defining businesses processes, as well as other important capabilities of monitoring and managing those processes. Services provide the functions, decisions, and information that support those processes. SOA provides the capabilities for services to be combined together and to support and create an agile, flexible enterprise. BPM without SOA is useful for building applications, but difficult to extend to the enterprise.
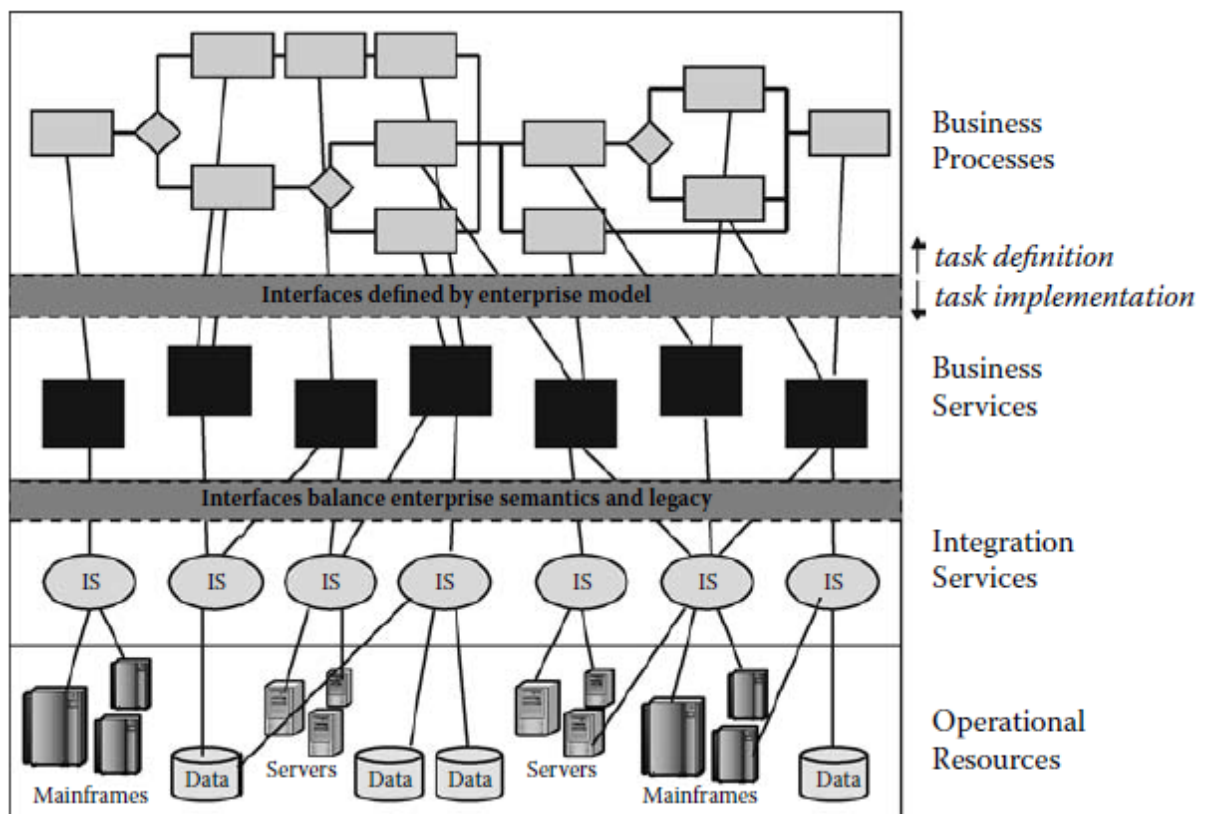
Figure 14: Layered SOA architecture. Source: Rosen et al. (2008)

SOA without BPM is useful for creating reusable and consistent services, but lacks the ability to turn those services into an agile, competitive enterprise. (Halle and Goldberg, 2009a)

However, the previous of SOA is missing a key component of enterprises and IT systems, that of the information. To make the architecture more complete (and realistic), we need to add the appropriate informational abstractions, including:

- Documents like high level business information.

- Semantics, the underlying meaning of and connection between the information, the context exchanged in processes.

- Transformation or conversion of information.

- Communication between services.

In figure 15 on the left are the functional concepts used to construct systems and processes. On the right are the informational concepts used to pass, describe, or manipulate data at those different functional levels. In other words, enterprises are a combination of process and information. Each layer needs both abstractions. Yet, too often, SOA only focuses on the functional aspects, ignoring the important data concepts.

6.5 Summary

Driven by the need to achieve greater insight into business activities, the enterprise IT departments are seeking effective and appropriate means to integrate their application portfolios. The main goals are transparency and coherency. SOA delivers business value by creating consistency, commonality, flexibility, decoupling and a decent management by SLA's.

SOA is the current and next generation of architectural style for computer systems. It is built around (automated) services. A foundation of SOA is the service inventory, and the quality of the SOA depends on how well the inventory is organized. One of the keys to achieving SOA success is creating a collection of services that can be combined together to support a variety of different business processes and scenarios. Loose coupling is important in reducing dependencies between services so that they can be used in different scenarios or to isolate the effects of changes.

BPM provides the higher-level abstraction for defining businesses processes, as well as other important capabilities of monitoring and managing those processes. Services provide the functions, decisions, and information that support those processes. SOA provides a modern approach suitable for Decision Models that integrates decisions into the overall enterprise and makes them readily available for business processes. Enterprises that understand the value of business decisions, and use them effectively through an SOA platform, will be steps ahead of their competition.
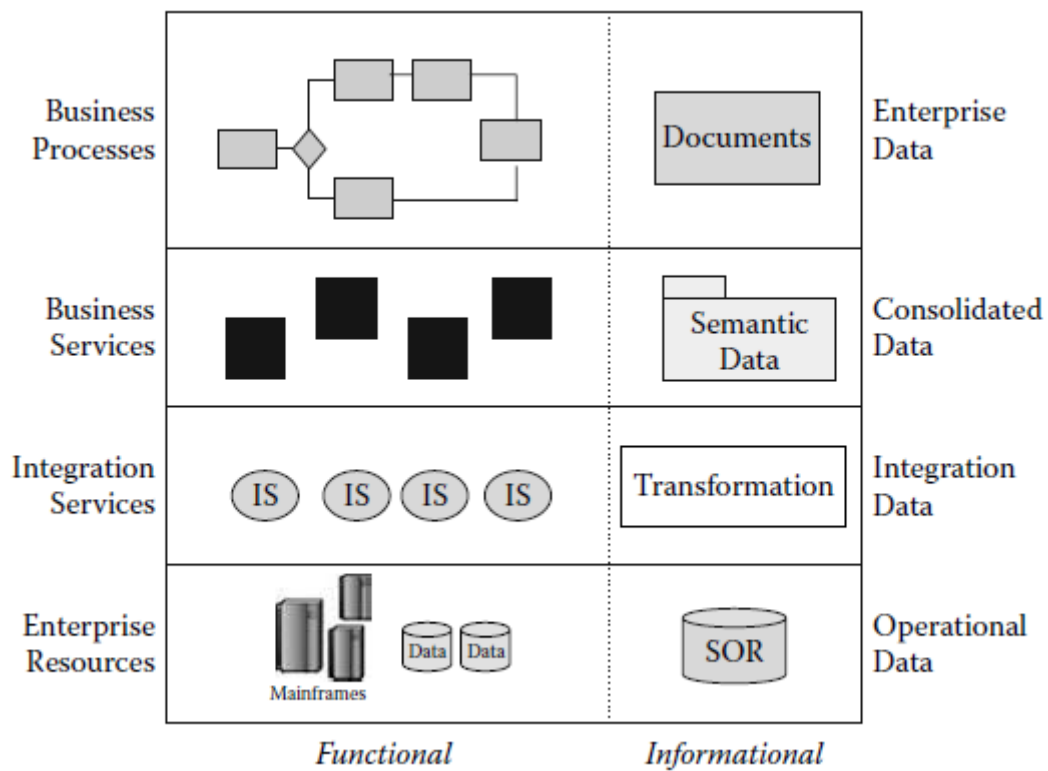
Figure 15: Components and data in a service oriented architecture. Source: (Halle and Goldberg, 2009a)

7 The OpenRules® platform

OpenRules® is a BDM System, available as an open source product. It is oriented to business analyst and subject matter experts (SME) allowing them to create, test, and maintain enterprise-class decision support applications.

They point out some key differentiators:

- Executable Decision Models in spreadsheet environment

- Business analysts are in charge

- Business rules without coding

- Integrated rules, predictive analytics and optimization

- Enterprise-class rules repository

Source: (OpenRules Inc, 2012b)

OpenRules provides complete support for executable decisions designed by business analysts directly in Microsoft Excel and they use no proprietary rule language as the rules are based on and implemented by Java code. Additionally, OpenRules supports rules-based web application development and integrates business rules with machine learning and optimization techniques. It is oriented to SME's (business analysts, not programmers) allowing them to represent, test, and maintain their business logic. It supports different decision modeling methodologies and is closely following the oncoming Object Group Management (OGM) standard Decision Model and Notation (DMN), for which OpenRules is considered by the OGM as a developer of the reference implementation.

In contrast with most commercial rule engines that provide an Excel-like graphical tool for rules management, OpenRules uses Excel directly as the delivery rule management tool. Without any coding, business analysts can create test cases in Excel and can actually execute their decisions in order to test if the expected results are being produced. Adding a rule testing phase into the business rule modeling cycle and keeping business people - not programmers - in control dramatically improves the quality of the resulting business rules repository. (OpenRules Inc., 2012c)

7.1 Platform Requirements

There are a number of needs common to BDM systems, such as: real-time decision making, large transactional volumes, the kinds of people involved both in developing systems and using them, some unattended decision making, and much more. These needs result in some specific requirements for products if they are to be successfully used in developing BDMS(Taylor et al., 2011):

Rapid Response Performance

With its focus on operational decisions, BDM can require high-performance systems. Operational processes often run in real time and require an answer or decision multiple times during execution. These decisions must be made rapidly enough to ensure that the process is not delayed. Even when people remain engaged in the decision, such as when options are presented for a person to choose from, the response time of the BDM solution is still critical when the user is engaged in a conversation with a customer, or a dispatcher is directing a truck or a service crew. This is particularly important for data and decision management components.

Operational Volumes

A consequence of the real-time performance requirement is the need to support very high volumes. The value of applying BDM in a specific area typically increases with a higher volume of decisions. In fact, some decisions for which BDM is used, are very high volume (thousands of transactions per hour) and even simple decisions can show clear ROI by providing consistency and quality to the collection of decisions. It is helpful, therefore, if technology for BDM can handle very high operational volumes as this will allow it to show a return on the widest possible range of decisions. In addition, these high volumes create a great deal of data, both transactional and about the decisions made. This data needs to be stored and sometimes analyzed immediately.

Transactional Integration

Many decisions are managed as part of a transactional context, for example financial transactions. To be effective in these circumstances, the technology used must support effective integration with the transactional systems, especially in areas like fail-over and time-out management. One of the key benefits of BDM is increased straight-through processing or unattended operation. This means the operational decision-making components of the system must be tightly integrated with the rest of the transactional environment. Analytic technologies, in particular, have not been tightly integrated with transactional systems in traditional implementations, which is unacceptable for BDM solutions.

Collaborative Development

Managed decisions exist at the intersection of business, information technology, and analytic expertise. To be effectively managed, therefore, all three groups must be able to collaborate on the definition, monitoring, and improvement of decisions. Technology that makes this collaboration easier and allows different amounts of complexity to be exposed to different groups at different times is particularly useful. This argues clearly for robust suites that can provide a seamless environment for all of these activities, with repositories that are durable and agile.

Whether this is provided by a single software vendor or assembled from components with a unifying abstraction layer is an open issue.

Decision Analysis

Decisions are not static but must be monitored and improved continually. As market conditions and competitors change, the effectiveness of a particular decision approach will also need to change. Tools that make it easy to monitor and improve decisions are more useful than those that are less transparent because they support more rapid identification of the changing effectiveness of decisions. Being able to conduct impact analysis and understand how decisions were made are advantageous when managing and improving decisions.

In addition, some decisions are formally audited, such as the price offered to a customer for a product, and others may have legal compliance issues, such as those in personal credit, insurance underwriting, or a multitude of government operations. Even where formal requirements do not exist, customers and managers may want to know exactly how a specific decision was made therefore it is necessary to have accurate logs available. Technology that supports accurate logging as part of making a decision, and that supports the integration of these logs across multiple products, is very useful. A side effect however this creates is the demand for data storage and management as the logs must be kept and made available for analysis.

Standards Support

Support for emerging and established standards is important in creating a fit for many BDM solutions that require multiple platforms or products connected together. Support for modeling standards such as Predictive Model Markup Language (PMML) and the Java Data Mining standard (JDM), as well as for emerging business rules standards like the Rule Interchange Format (RIF) and Production Rule Representation (PRR), allow decision specification to be shared. Support for user interface implementation standards, like those relating to Portlets, allows integrated portals or monitoring environments to be developed while support for data standards allows for easier data integration. The standards for BDM are still evolving, and it is not yet possible to develop solutions based completely on standards. Nevertheless, the support of standards by products and vendors should be an important consideration going forward. (Taylor, 2012)

Simulation and Testing

An ability to simulate or test a decision before putting it into production can be enormously powerful. Decisions are often complex and their impact can have tremendous effects. An ability to effectively simulate a decision before deploying it makes it possible to see what will happen. Simulating a single decision can be useful, but it is even more valuable to simulate

the impact changing a particular decision has on other stakeholders down the line. Changing a decision might impact those downstream at other points in the life cycle, or it might change decisions made for other transactions. A good simulation and testing environment should allow this kind of cross-decision analysis.

Service Oriented

The most essential requirement is perhaps the support for a component-based or service-oriented approach. When a complete system uses a service-oriented approach, enterprise decision management solutions are more effective. So do applications which technologies fit in better with a service-oriented architecture. Suitable technologies may be service-oriented themselves, allow access from service-oriented applications, or merely be compatible with a service-oriented approach. Being able to package up rules, optimization models, and analytics into coherent and self-contained decision services is one thing. Ensuring that all the data, integration, visualization, and reporting that these services might need are likewise available is another. Solutions using BDM systems require multiple technologies to be used in combination, and they must be integrated with systems of record and transactional environments. Using a service-oriented approach allows decision services to be managed as reusable assets, easily integrated with other systems, and helps ensure that ongoing changes in the decision-making logic are isolated to a single coherent component. Support for service-orientation in the products used is essential.

7.2 Components

OpenRules relies on proven open source tools created and maintained by different contributors. The downloadable OpenRules software includes copies of related freely distributed 3rd party products in accordance with their open source licenses. The framework utilizes commonly used tools like the Eclipse IDE, Google Docs, Java API and server tools. It provides a suite of open source components for rules-based application development and it covers all major phases of a BRMS, currently evolving to a BDMS:

- Rule Learner - for rule discovery, predictive analytics and testing

- Rule Engine - for rules execution

- Rule Validator - for business rules validation and error diagnostic

- Rule Repository - for management of enterprise-level decision rules

- Rule Editor - support for Excel, OpenOffice and Google Spreadsheets

- Rule Solver - for solving constraint satisfaction and optimization problems

- Rule Deployer - for deploying with Java API, Web Services and Web applications

- Finite State Machines - for event processing and "connecting the dots"

- Rules Dialog - for building rules-based Web questionnaires

As we said before, there is a difference between business rules and business decisions. The scope of this thesis has shown the applications beyond the use of business rules in business processes and the integration of business decisions and services. Next we describe the components present in the OpenRules package. Information from the OpenRules online website informs us that they also have taken improved steps in creating a business decisions platform:

> "Integration of these components with executable decisions has effectively converted OpenRules ® Release 6 from a BRMS to a BDMS, Business Decision Management System, oriented to "decision-centric" application development." (OpenRules, 2011)

Next, the OpenRules components will be introduced, explained shortly and evaluated, comparing it to the information available in the literature study from the previous chapters.

7.2.1   Rule Learner

One of the most popular techniques of Machine Learning (ML) is the extraction of classification rules and patterns from massive data sets; the module that does this work is called a Rule Learner. It designs and develops algorithms that allow computers to evolve behaviors based on empirical data, such as from sensor data or databases. Today's ML offers powerful algorithms and tools for practical knowledge discovery, however they operate mostly as stand-alone applications. At the same time, rules discovery is an important part of the rule harvesting process, that is a key component of any enterprise BRMS. By implementing a Rule Learner, OpenRules enables predictive analysis, an important component of BDM.

OpenRules is trying to answer the question to combine ML and business rules with a Rule Learner BRMS component and practical integration tools. OpenRules Rule Learner is based on a supervised ML approach that requires Training Sets for its execution. A Training Set usually consists of examples indicating when the desired result has been achieved (positive examples) and counter examples indicating cases when the desired result has not been achieved (negative examples) to discover new business rules. Supervised learning requires a trainer to create training sets. Usually a trainer is a SME who has extensive experience dealing with the historical enterprise data and has the competence and skills to establish goals, concepts, and/or criteria, for detecting patterns and rules. It is also possible to automate the trainer function and make it an integral part of the system architecture. OpenRules developed all the necessary components for an integration of ML and BR that allow an enterprise to combine different learning algorithms and rule engines.
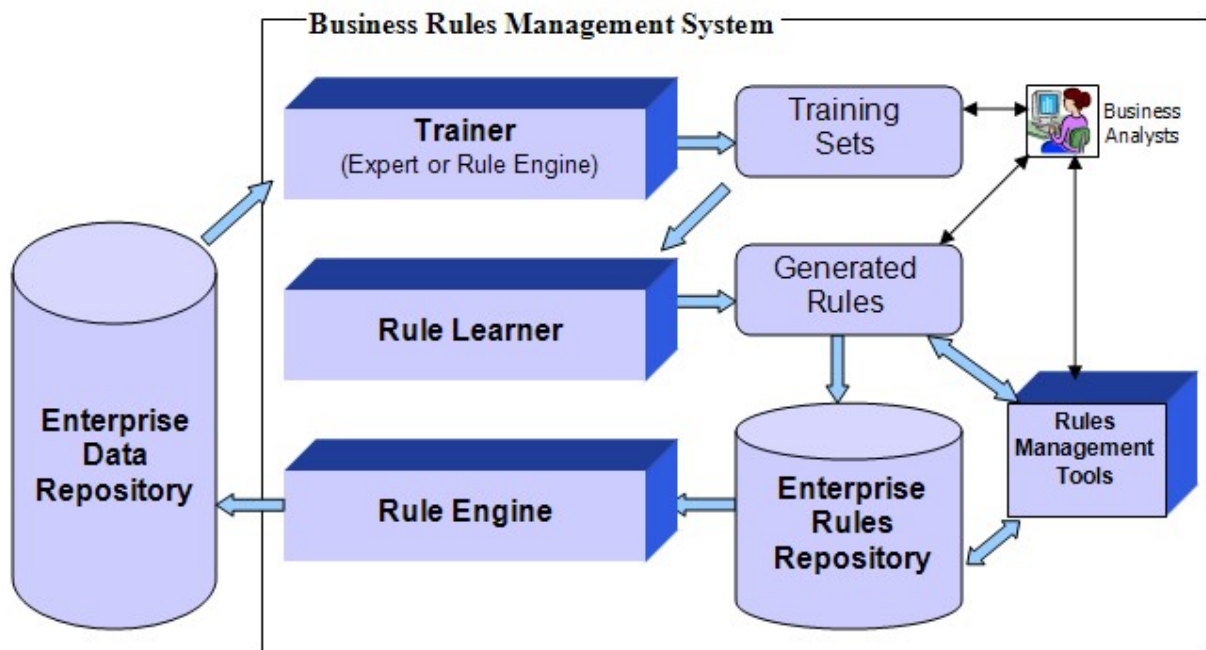
Figure 16: Rule Learner Architecture. Source: (OpenRules Inc. 2012a)

The Rule Learner is an integral part of OpenRules (see figure 16), and follows the major OpenRules principles: it is designed to be used by business analysts and it is designed to be presented or manipulated using spreadsheet software without the introduction of new languages. While the discovered rules by default are generated as OpenRules decision tables and placed in different Excel files, the approach and its implementation are generic enough to use different formats and other rule engines.

The approach used has already showed some benefit, as the software is fore example used by a governance instance, the Internal Revenue Service (IRS). The objective of this project is to integrate ML results into a standard business rules environment in a way that will allow IRS subject matter experts to easily identify any gaps between the rules developed by its experts to detect potential non-compliance and the rules automatically developed by the ML system. The IRS expects that an integrated approach of automated knowledge discovery with business rules authoring, if successful, will result in a sophisticated feedback mechanism for operational enhancements. (Feldman, 2006)

7.2.2 Rule Engine

OpenRules include a rule engine known as 'OpenRulesEngine' that is used to execute different rule sets and methods specified in Excel files using application-specific business objects, defined in a glossary. OpenRulesEngine can be invoked from any Java application using a simple Java OpenRules API or the standard JSR-94 (Java Rule Engine API) interface.

If a business rule is changed, OpenRulesEngine automatically reloads the rule when necessary. Before any engine's run, OpenRulesEngine checks to determine if the main Excel file associated with this instance of the engine has been changed. Information on the performance of the Rule Engine can be found under subsection 7.5.

7.2.3 Rule Validator

The overall environment looks very intuitive for a non technical user as most rule management time is spend using spreadsheets known to a vast majority of business and technical users, but obviously keeping everything consistent in Excel has challenges once users start editing extensively. Some problems like wrong formatted rules or typing errors will only show at compile time and semantic errors are even harder to discover.

A solution OpenRules offers is an Eclipse plug-in, a de-facto standard project management tool for software developers within a Java-based development environment, to allow developers to check an Excel file for errors. OpenRules has been designed to catch as many errors as possible in compile-rime vs run-time when it is too late. Almost every developer tool has standard error checking at compile time, but this can be already a step too far to be used effectively by business users. At least some training will be necessary in educating business people in the setup and use.

A second option is to use the stand-alone version of OpenRules without the Eclipse IDE, which still enables to validate Excel-files. OpenRules provides a special validation module, the batch Rule Validator, that allows you to test all of the xls-files contained in your rule project.

7.2.4 Rule Repository

Logical and Physical Rule Repositories   OpenRules utilizes the well-established spreadsheet concepts of workbooks, worksheets, and tables to build enterprise-level rule repositories. Each OpenRules workbook is comprised of one or more worksheets that can be used to separate information by types or categories. (OpenRules Inc., 2012a)

Logically, the OpenRules Repository may be considered as a hierarchy of inter-related Excel workbooks. Each rule workbook may be comprised of one or more tables. Most typical OpenRules tables are decision tables that are used to represent business rules. However, along with rule tables, OpenRules supports tables of other types such as: Form Layouts, Data and Datatypes, Methods, and Environment tables to create a better overview and structure.

Physically, all workbooks are saved as standard xls- or xml-files with well-known formats. There is also support for external rules, as seen above; import from xml-files, Java or as external rules from a database - as long as it's structure corresponds to the proper Excel template.

Decision Model Business Logic   As we have explained before, the Decision Model is a way of representing business logic that is platform and technology independent. It models logic

RuleFamily PersonLikelihoodOfDefaultingOnLoan							
	Condition		Condition		Condition		Conclusion
Rule Pattern	Person Employment History		Person Mortgage Situation		Person Miscellaneous Loans Assessment		Person Likelihood of Defaulting on a Loan
1	Is	Poor	Is	Poor	Is	High	Is	High
2	Is	Good					Is	Low
1	Is	Poor	Is	Poor	Is	Low	Is	Medium
3							Is	Undefined

Figure 17: Rule Families in OpenRules. Source: (OpenRules Inc. 2011)

based on the inherent structure of that logic, eliminating style and other subjective preferences, ensuring a consistent and stable representation. The business logic OpenRules uses (see figure 17), can be based on this Decision Model and is the same compared to the general representation of rule families.

Rules Authoring and Maintenance   To make it more easy to maintain and author the rules present in the repository, the tools that OpenRules uses, are open source and make use of standards or a version control system (as seen in figure 18). It allows the user to revert a file to a previous revision, which is critical for allowing multiple editors to track each others edits, correct mistakes, and defend against malicious use. Software tools for revision control are essential for the organization of multi-developer projects.

    OpenRules has no own implementation for maintenance tools like version control, but relies on the various external software packages available to take care of that issue. It's a good way as these tools are integrated standard like in Google Spreadsheets. This way users don't have to take care of them but users have to be made aware of their availability and advantages. Another disadvantage is that a user need to have the knowledge to maintain them, especially with more advanced version control or database management tools, which are more difficult to setup and use.

7.2.5   Rule Editor

OpenRules uses standard spreadsheet files to represent business rules, test data, forms, and methods. It allows OpenRules users to use standard spreadsheet editors such as MS Excel™, OpenOffice™, or Google Docs™ as rule editors. The use of standard tools and consequently familiar user interfaces gives customers easy access to very powerful features without committing them to a lengthy learning curve. With OpenRules both business analysts and program-
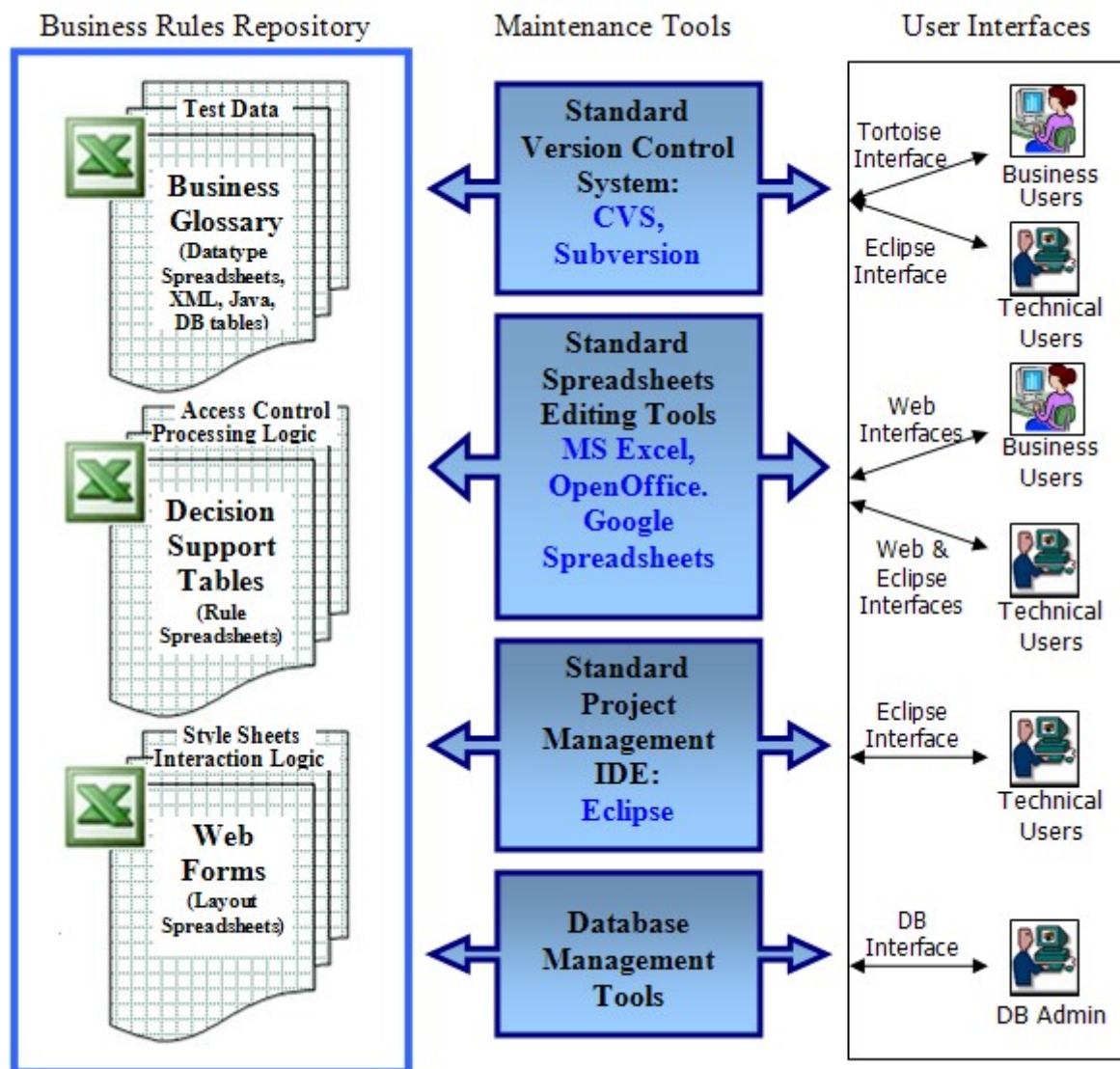
Figure 18: Rule maintenance tools in OpenRules. Source: (OpenRules Inc. 2012a)

mers can use MS Excel directly to create and edit business rules spreadsheets. MS Excel is a standard tool, know to many of us, placing the Rule Editing in a familiar context.

MS Excel has also a built-in feature to protect files, this way a layer of security is already integrated, preventing a user from accidentally or deliberately changing, moving, or deleting important data from a rulesheet or rulebook. On the downside, one argument of OpenRules is that other software tools don't have this direct input and thus have to use an intermediary way of importing rules. However it is still possible that in a certain company business rules aren't defined in spreadsheet and yet still have to be imported.

Collaboration Using Google Docs™ a rules administrator can invite interested parties to share business rules spreadsheet and work together in the process. Google Docs provides a decent environment for collaboration. When one of the users makes changes to the spreadsheet, the other person can see the changes in real time and respond to the edits immediately. All parties involved can work on the same file, so there's no need to send attachments back and forth, comparing and consolidating individual files.

As seen before in 7.2.2, rules are also updated dynamically as OpenRules check for their consistency. This adds an extra check to make sure that the executed rules run consistently without differences in the various rules. This is especially important in an environment where the business logic is updated frequently or a lot of parties are involved.

7.2.6 Rule Solver

OpenRules BDM system includes a special component called Rule Solver™ that applies Constraint Programming (CP) techniques to model and solve scheduling, resource allocation, configuration, and other constraint satisfaction and optimization problems. Rule Solver™ makes use of advances techniques like constraints programming and linear and integer programming in finding optimized solutions. The details of these techniques are beyond the scope of this thesis. By using the Rule Solver™, it tries solves complex decision support problems when a pure business rules technique is inadequate. Examples like scheduling and resource allocation are traditionally considered as very complex business problems and usually out of reach for the most rule engines.

(Feldman, 2012), CTO at OpenRules, states that with the OpenRules software even complex scheduling and resource allocation problems can be modeled relatively easy without programming. Note however that mostly decision models only define problems and do not tell anything how to resolve them. Concentrating on "what" and ignoring "how" is a natural approach for a modeling environment such as OpenRules Rule Solver™ that is oriented rather on SME's than on software developers.

7.2.7 Rule Deployer

OpenRules-based applications can be deployed using three major approaches: as components of Java applications, as web services or as presentation-oriented Web Applications (see also the next subsection on Rule Dialog). Software deployment is all of the activities that make a software system available for use and is interpreted as a general process (release, install, update, adapt,..) that has to be customized according to specific requirements or characteristics.

In deploying OpenRules applications, users can use the commonly known Excel interface, define their own business logic in the form of Excel-based business rules and make them available as fine-grained Web services. You also may define a presentation logic using Excel-based web forms with associated interaction rules, however this is a more tedious task and is better left to people with more technical knowledge. The presentation layer in OpenRules - for example HTML code - is also handled inside Excel and so makes it less clear to implement and manage, opposed to a external HTML editor.

7.2.8 Rule Dialog

The OpenRules Rule Dialog (ORD™) is a software product built on top of OpenRules BDMS. It is a Web tool that can be used to create a service for customers, deployed via the Web. It allows non-technical people to develop and maintain Web-based questionnaires (dialogs) using only Excel and without a need to learn complex web programming techniques.

Let's consider the example where the service is provided to help customers fill in the details of their tax form. Via an user interface (the Web page) the user is guided in the process whereby the presentation and the logic behind the service is directly supported by OpenRules. The business and presentation logic for building complex questionnaires is presented in predefined Excel-based rule templates and layouts available for learning and changes. A questionnaire is a web application that is described in terms of pages, sections, and different types of questions. Layouts of pages, sections, questions, and complex relationships between them can be expressed in a very natural way using simple and intuitive Excel tables. Table 2 show a table of possible variables for the questions, used to collect the data.

Various business rules can be defined in the OpenRules application (even using a Decision Model) to make sure that the user provided data is entered and processed correct. The next step, after the user has submitted the request, is that the service uses the business logic and rules to generate the adequate tax report and display it back to the customer.

From table 2 it is clear that no complex developer code is used, only some standard and understandable predefined types like TextBox, RadioButton, Message, etc.. Of course the user has to be familiar with the basic data models and structures - the basic Excel tables - used by OpenRules. Besides this is only part of the application implementation, as this not includes installation and deployment of the app. The current ORD™ distribution is oriented to be used with Eclipse or a similar IDE, but it can also be used as a stand-alone system with just Excel

Rules **questions** extends questionsTemplate				
Question Id	**Question Name**	**Question Type**	**Size**	**Validation**
ApplicantFirstName	First Name	TextBox		
ApplicantLastName	Last Name	TextBox		
Gender	Gender	RadioButton		
AddressLine	Address	TextBox		
City	City	TextBox		
State	State	TextBox		
HomePhone	Home Phone	TextBox		REGEX[0-9]{3}
HomeEmail	Home Email	TextBox		EMAIL
DOB	Date of Birth	TextBox		DATE
Income	Annual Household Income	TextBox		Range 100000 10000000
EmploymentType	Employment Type	ComboBox		
Completed	Your tax report has been completely filled. Press 'Submit' to submit your entry.	Message		
SubmitApplication	Submit	ActionButton		
Submitted	Your tax report is succesfully submitted.	Message		

Table 2: ORD question example.

and Windows Explorer. And it is also necessary to install any Java-based Web application server and they assume that a (free) Apache Tomcat server is already installed. Clearly this isn't a task for business people.

7.2.9 Rule compressor

Business Rules have a tendency to grow quickly and they can become easily redundant. Several conditions can be present multiple times in the logic. Given any decision table the compressor looks for redundant rule combinations and removes them. For example if you have two rows in the decision table that look like this:

- if age > 50 then decrease price by 10%

- if age > 65 then decrease price by 10%

Than there is a redundancy and the logic can be combined into a single rule: if age > 50 then decrease price by 10%. The Rule Compressor is a special add-on that uses the integrated ML+business rules approach to automatically compress complex classification rules, this includes test data from the Rule Trainer (see subsection Rule Learner) to which the rule can be applied. The Rule Compressor is a very powerful tool, relying on ML in an attempt to get rid of redundant data.

What rule compression doesn't do however, is teach the business user how to write better rules, or point out inefficiencies in their decision process. It is definitely beneficial to have a tool

like the Rule Compressor to start the analysis, but that is not the only step in creating good business rules.

7.3   Architecture

Being a BDMS, OpenRules® provides a suite of open source components for development of custom decision support applications, as they make use of other tools like Excel, Eclipse and Java. The application makes use of these tools and uses them as tools for delivering the available functionality and combines everything together into a powerful BRMS product. Extensive reuse of proven, commonly available software results in a framework that matches or exceeds similar commercial systems in speed, compactness, and ease of use.
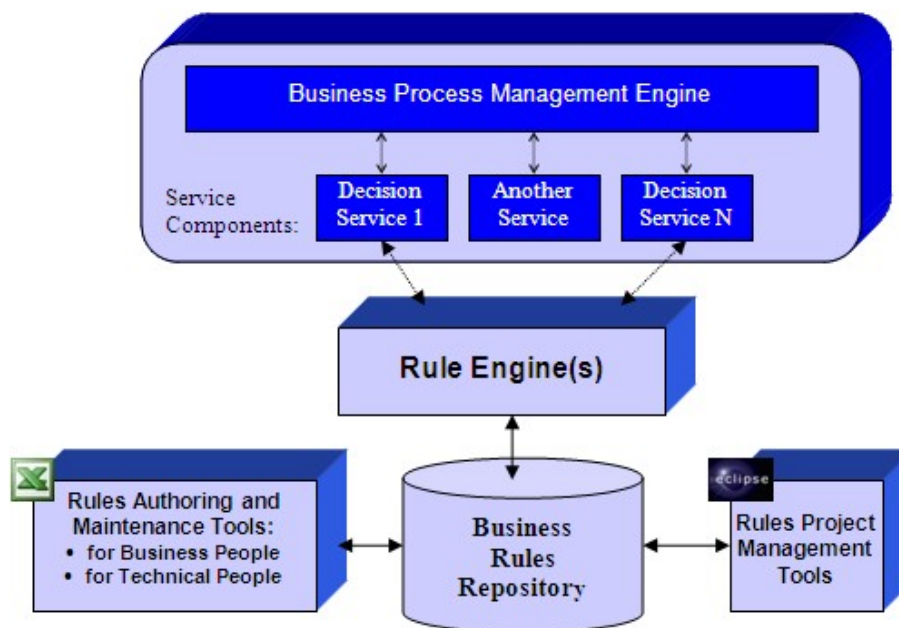

Figure 19: Service-Oriented Architecture with Decision Services. Source: (OpenRules Inc. 2012b)

Previously in section SOA, the main practices of a SOA where explained. Fundamental to a service model is the separation between the interface and the implementation. The user of a service need only needs to understand the interface; the implementation can evolve over time without disturbing the users of the service. A benefit of this approach means that, the same interface can be offered by many implementations, or conversely, that implementations can change without affecting the aggregate application. The service model has been called "fractal:" the newly formed process is a service itself, exposing a new, aggregated capability.

On figure 19, the architecture OpenRules can provide supports this approach, considering its rules-based decision services as another type of loosely coupled services. When an event controlled by a rule occurs, BPM engine invokes the associated rules-based service to make

application specific decisions. These rule services usually receive clearly specified input/output objects and a reference to the business rule sets to be examined during service execution. At run-time, the rule service executes a rule engine passing to it input/output objects and rule sets from a business rules repository. (OpenRules Inc. 2011)

The services can be used in business processes, applied together with the Decision Model. Using the Decision Model, a designer predicts confidently the structure and complexity of the business logic behind a simple interface. By encapsulating the Decision Model behind a business decision into its own service, the designer of the larger service achieves a separation and externalization of the business logic from a larger set of services. This increases the flexibility of the design to meet the objective of the architecture. (Halle and Goldberg, 2009a)

7.4 Optimization

For real-world problems where many alternatives are available, it is often too tedious or just impossible, to create - and maintain! - thousands of rules to cover every possible combination of problem parameters. At the same time, optimization is a well-known technology for calculating the best possible utilization of resources, (e.g., people, time, processes, vehicles, equipment, raw materials, supplies, capacity, securities, etc.), needed to achieve a desired result (minimum cost, minimum process time, maximum profit, etc.). An optimization problem is specified as an objective function and a set of constraints over some variables. A solution to the problem is a set of values for the variables that satisfies the constraints and minimizes/maximizes the objective function.

Today an integrated use of business rules and optimization techniques is especially important to address Online Decision Support problems such as online reservation, services scheduling, offer generation, etc. These online problems are characterized by frequently changing constraints and multiple alternatives with very limited time to find the most optimal solution. In all these situations, it makes sense to create business rules that define the search space and then to apply an optimization technique to find the best possible alternative.

Modern optimization technology often involves techniques from several disciplines including operations research, artificial intelligence and mathematical logic. Constraint Programming, Linear and Integer Programming are among the most popular optimization techniques. Open-Rules includes a special component called Rule Solver™ that applies these techniques to solve optimization problems defined in the rules-based environment. The following figure 20 describes how the integrated use of Rule Solver™ and Rule Engine can be applied to Online Decision Support.

The ultimate objective of BDM is that of optimal decision making. Constant use of adaptive control techniques will improve a decision, making it increasingly optimal. Some decisions lend themselves to optimization where an optimization model can be used to find the best result given the constraints and tradeoffs of a decision.(Taylor and Raden, 2007)
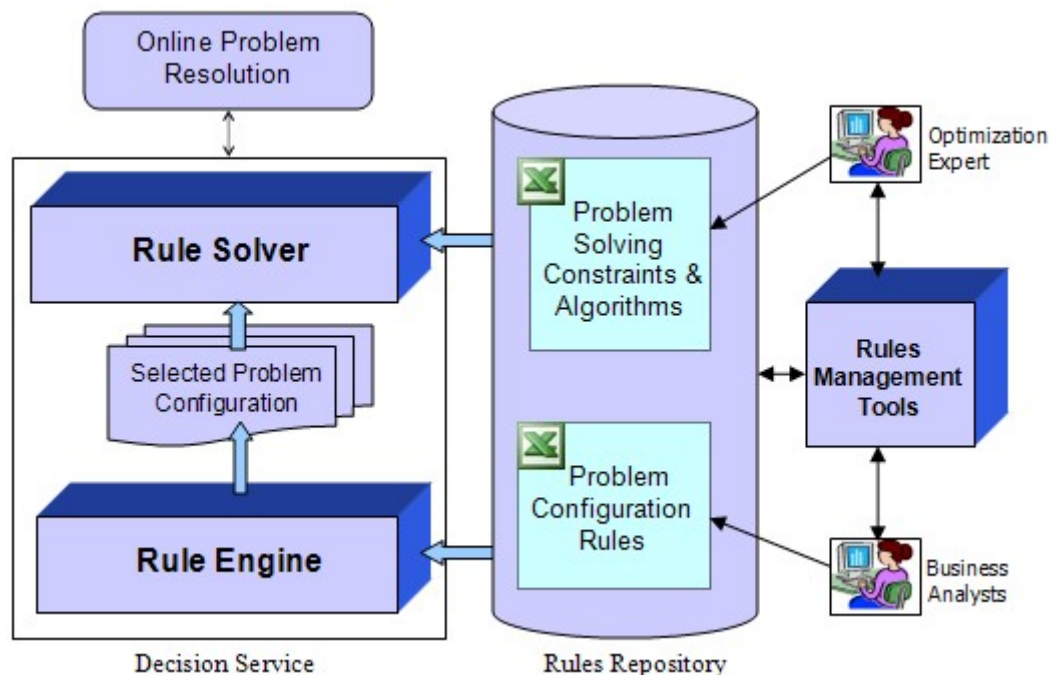
Figure 20: OpenRules Rule Solver. Source: (OpenRules Inc., 2012b)

7.5   Evaluation Topics

In the previous sections, the components have been explained, including some ideas on the approach that is used by OpenRules. Here in this section some extra information in particular will be highlighted, considered important in the review of the platform.

7.5.1   Rules Management

In the current version of OpenRules, users have a choice between rules and decisions (with glossary and decision tables). They even may mix both approaches: we already see the situations when users start with decisions but add their own Rules whenever necessary, taking an advantage of the fact that they always have an access to objects defined in the glossary. They also may customize the decision templates (available in Excel) to add an additional functionality. OpenRules provides support for a great amount of business rules templates to incorporate organization-specific terms and make them easier for non-technical users to understand and edit. And when users have a choice, they will always find the best alternative for their particular technical and organizational environment.

Management of the business logic, including the application of the Decision Model gives OpenRules a profound basis to build a decent set of rules and decisions. However there is the lack in storing additional information and tools to manage that information. The tool should have features for maintaining the glossary of fact types, and other metadata that is important to the business logic, such as version, status, and business motivation.

7.5.2   User Interface

Rule Editing   Excel provides a graphical representations of the data, glossary, business rules and decision tables as we have seen previous in this thesis. These representations further ensure that the decisions can be managed by those who understand the business context of those decisions. No hidden code and doing everything in spreadsheets, also means that business people can define and maintain their business logic by themselves with no IT involvement. IT participation may be limited to an integration of decision models, created and tested by business analysts and deployment using the preferred application. Developers do not even have to look at Decision Tables as both concerns are separated.

Inside a hidden technical view, developers can use Java code directly to describe semantics of rule conditions and actions of any complexity. Rule templates allow our users to move technical views to a limited number of templates while hundreds and even thousands of rules were created based on these templates. It separates rules management responsibilities: IT specialists help to create templates and business specialists create and maintain rules based on them.

A good BRMS presents the business logic in the form of business rules that are intuitive for business users, and can be easily maintained by them through a friendly graphical user interface (GUI). Next to the standard spreadsheet environment, additional functionality in a decent UI is lacking. A graphic overview of the tables improves readability, although it even have to be said that when systems get complex, MS Excel isn't the best tool. There is some structure, worksheets can be 'included' into other sheets to connect rule categories but if structure becomes more complex and a lot rules have to be structured it can be easy to loose an overview in the spreadsheet editor.

It is easy to get lost in a complex database of rules and decisions. It would have been appropriate if any additional views of the repository where available, beside the spreadsheet environment. For example it is very difficult to search for a particular rule, or to find any related rules and decisions. A decent overview where users can browse throughout the repository is a feature that is lacking, and representations like those in figure 21 are not sufficient.

Run-time environment   Code have to be run inside Eclipse directly in Windows, but even here there is a lack of a decent presentation layer. Decisions is easy by a simple double click, but the GUI where a business user can view information about the service, is merely the text console of Windows or the log window of the coding environment (Eclipse IDE). Information about the execution, error and warning information is presented in a small text box, making it difficult to identify errors and correct them in a easy way.

Please note that these issues are considered from the viewpoint of business users, who have more difficulties understanding a technical environment than IT people. However a decent GUI not a luxury for improving usability even for more technical users.
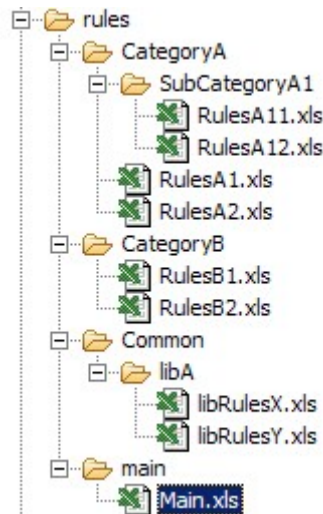
Figure 21: Overview of different Rules in the Eclipse IDE

7.5.3   Java Code

Consider the example of creating a business rule to define the current hour when a decision is executed. Instead of using a fixed current hour specified in the data, a better solution is defining a simple decision table that sets the current our based on the actual time of the day. OpenRules enables the using Java snippets (a short line of JavaScript code) inside the decision tables in the spreadsheets editor. Of course, the user need to know Java to write such a formula, and in a lack of skill, the business user has to ask the help of a software developer to create the proper code. This adds to the complexity, as a developer is not always available on-demand. Plus for a software developer, is it more convenient to use his own coding environment instead of implementing and testing code in a spreadsheet cell.

7.5.4   Performance

Test cases have been run, using OpenRules for very high user load and very high operational volumes. This makes the software usable at a broader scale as the Rule Engine is able perform decent under a higher load. OpenRules® has been used as a component of complex real-world applications for the last 7 years, and it has proven its superior level of performance and scalability. A case study demonstrated that OpenRules scales to more than 300 concurrent users on a system where each and every concurrent user executed its rules 10,000 times. As the result in figure 22 on the next page shows, when the number of users increase the time taken to execute a transaction stays at a stable level.
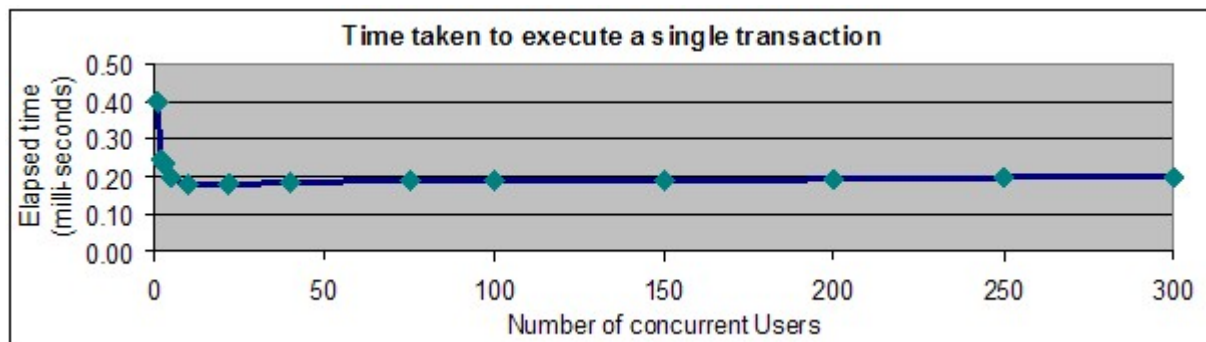
Figure 22: OpenRules Rule Engine Performance Source: (OpenRules Inc., 2012b)

7.5.5 Standardization

Another requirement for a good BDMS is the supports of standards. In structuring the business logic, the Decision Model is supported by OpenRules, providing a improved model that is a good step towards standardization. As the model is supported by a whole set of principles to ensure a uniform and clear representation of the logic. As discussed before, there are some technologies emerging in standardizing decisions, yet their implementation is at a higher level of maturity as supposed to what is achieved today. Also in OpenRules there is no sign of using a standard decision language.

On the other hand OpenRules doesn't use a specific rule language as rules are implementing using Java code. This provides a layer in between to structuring and creating a standard as a own rule language would increase complexity and the need for intermediate code to make the language standard.

7.5.6 Comparison

Although this thesis has not compared OpenRules to other platforms, (Forrester Research, Inc. 2011) says "OpenRules have the most-aggressive approaches to business-expert authoring and typically requires less developer support than IBM ILOG, FICO Blaze Advisor, and JBoss BRMS."

7.6 Summary

OpenRules seem to do a pretty good job in providing the requirements for a BDM system, implementing a whole range of components from rule discovery and harvesting, management, storage, execution, optimization and deployment into different applications. Business users are mostly in control of creating and managing the rules, however a better user interface can improve the usability of the application. Technical users have a decent set of tools for deploying the applications and thereby the attention also goes towards a service-oriented approach.

The system doesn't provide an all-in-one fancy package where a few clicks can lead to excellent management of business rules. It can be some puzzling to figure out how everything works together. The learning curve for the software is moderate, but some initial training is necessary. Probably one of the reasons OpenRules is providing an extended service in consulting and training. Basic features are put in the hands of business users, a promise OpenRules seems to keep, but to get the benefit of the whole package the support of IT is indisputable. However as the current stage of development and exploration of BDM systems is still young, OpenRules is a step in the right direction.

8 Business-IT Collaboration

This part gives a general overview and summary of best practices and ideas for better business-it alignment and collaboration. Throughout the thesis, several ideas, tools and approaches have come to light, having a negative or positive effect on the collaboration.

BRM and BDM systems have a profound impact on the company's way of working. Managing and using (automated) knowledge create different structures, architectures and services. People of all levels, management and staff have to work every day with the tools made available by BRMS and BDMS in creating better decisions and to increase a company's profit.

Designing the repository, giving business users rule management capability, verification, testing and deployment will all be simplified by focusing on specific decisions.

Modern BRM and BDM platforms are great in representing, executing and maintaining rules. The real strength could be lying in creating a solution that only needs to be maintained; but building it right in the first place is something more difficult. A lot of tools provide a good package for managing more simple decisions. Computer systems are still evolving in artificial intelligence, in many cases exceeding human potential in terms of speed. But you still have to tell a system in the first place what to do and for now high complex decisions like defining strategies, still remain a human task.

Given the importance of systems and processes to today's organization, business performance improves when business and IT practices are aligned. Processes and systems are aligned when the business and IT have a shared understanding of the work flow and the logic in a system. They are aligned when the business has an appropriate level of access and control of their systems.

8.1 Operational Excellence

Operational excellence supports agility by enabling a more rapid rate of change - current processes and systems should not be bottlenecks to strategy adjustments. Changes should only be made once to be effective throughout the complete organization so change must also be flawless. The process of change needs to be reliable too. Speed in operations also improves the time-to-act, which is the elapsed time between discovering a new insight and implementing it. An efficient set of business processes frees up the resources and the time to focus on other processes that provide competitive differentiation, mainly those around management excellence. Change management is a crucial competence to be able to change IT systems smoothly and quickly, in order to keep up with the pace of business change. (Buytendijk et al., 2009)

8.2 Alignment Benefits

Companies adopting BDM report game changing cultural impacts. Simpler processes, more flexible business applications, an increased capacity for change and improved business alignment - decision management enhances business process management to deliver greater value to the business. BDM focuses on the decisions at the heart of the business processes. BDM makes them explicit and gives the business control over how those decisions are being made. BDM provides the ability to adapt to change with increased speed and agility, align business units and IT through enhanced visibility and governance, and act in real time with high performance and reliability.

8.3 Enablers

The business decision and Decision Model are assets that gain high business management attention. As such, it is easier to incorporate them earlier in business-driven projects, such as BPM, process improvements, and business transformation efforts. That's because business people easily recognize that it is difficult to find much business value in an individual business rule or business logic statement, but there is much value in evaluating and managing the performance of entire business decisions. Therefore, Decision Models (even without exposing their detailed business logic) and decision services emerge as a fundamental asset that drives the business toward its objectives.

Efficient BPM is an enabler for better alignment, achieved in several ways as explained throughout the thesis. Business processes must be automated as much as possible, with the least amount of human interaction, creating cost-efficient and providing high quality and increased speed. Standardizing them and externalizing decisions and services, so that changes made are immediately available across the enterprise.

8.4 Change Management

As seen in the previous section, efficient and effective processes become an enabler for better alignment. An efficient set of business processes frees up the resources and the time to focus on other processes that provide competitive differentiation, mainly those around management excellence and change. Change management is a crucial competence to be able to change IT systems smoothly and quickly, in order to keep up with the pace of business change.

Organizations cannot change more quickly than their systems - when systems are hard to change, organizations cannot react quickly or effectively to new opportunities, new regulations or new challenges. Manual processes are no better as updating policy manuals and retraining staff is time-consuming and expensive. BDM further increases this capacity as business changes often involve updates to business decisions. These decisions are often the most dynamic part of a process, the part that changes most often.

IT is moving from a state of being the custodians of applications and infrastructure - providing what participants need currently - to being a supplier of tools and technology to enable the participants needs now, and into the future. As business moves at a faster pace, and business users become more technology savvy, IT must anticipate the needs of participants, and enable them. An effective IT strategy, fueling technology excellence, needs to be complete, open, and integrate. (Buytendijk et al., 2009)

8.5   Analytic Groups

BDM typically requires close collaboration between IT, analytics, and business groups. In most organizations these groups rarely, if ever, have collaborated deeply before. Business users are used to asking IT to develop systems; they where an enabler for business needs, working only in one direction. Similarly, IT departments are often reluctant to allow non-technical business users to participate actively in development and they will need to partner more effectively with business users. Analytic groups often work in splendid isolation, focusing only on the accuracy and predictive power of their models. This will not support the BDM model. However there are some techniques that can be used to overcome these barriers (Taylor et al., 2011):

- Conduct cross-training exercises across the various groups involved to at least develop an awareness and understanding of other groups. Teaching programmers some of the basic concepts of analytic model development and introducing analytic staff to the test and deployment process used by IT can help increase understanding. Training where all the groups involved attend the same class can also help build a cross-functional team environment.

- Start in areas where the groups currently have established working relationships.

- Bring analytic and business staff into discussions of technical details at least at the level of trade-off analysis to increase buy-in.

8.6   Summary

Business-IT Alignment is a much spoken about topic nowadays. Yet companies still have a lot of difficulties to implement and maintain a good relationship between business and technology practices. BRM and BDM technologies provide an adequate set of tools in creating a better alignment. By focusing on operational excellence, (human) resources become available to be used where they matter the most. Business logic management, using the Decision Model and integrating decisions into BPM create a focus on the decisions at the heart of the business processes, becoming an enabler for better alignment.

Change management is a crucial competence to be able to change IT systems smoothly and quickly, in order to keep up with the pace of business change. An effective IT strategy,

fueling technology excellence and enabling change, needs to be complete, open, and integrate. Also in applying analytics, close collaboration between IT and business is necessary and can be overcome by including training to increase awareness and relationships of people involved.

9 The Future

One thing that every business in every industry wants today, it's improved operational responsiveness; constant access to the right information so their operations can react quickly to marketplace changes and, where possible, being pro-active too. BDM is gaining more support to help companies move toward real-time responsiveness to both opportunities and threats.

Event processing and predictive analytics could be the future, they can help companies become more agile by using real-time data to make decisions and take action much faster. They may change how business decisions are made, but this approach will also have to be linked to strategic goals, improving the maturity of the company, including finding people with the right skills.

9.1 Cloud Solutions

One can't leave all the decisions to the a operational system, business process, platform or person, as there has to be a human point of control to prevent mistakes or bad decisions, but a good solution is to leverage the combined strengths to enable sound decision making. (Peckman, 2012) defines the strengths by taking information from everywhere (really everywhere – transactional, social media, call center notes, video, sensors, etc.) with an end goal of providing recommendations for an action or service, such as identifying claims fraud or reducing costs via preventative maintenance. More specifically, organizations can now employ these systems in the Cloud using all of its proprietary "local" data along with cloud-resident data to tie strategy to execution by means of decision management systems.

There is a growing trend for offering service-oriented products "in the cloud" or as a service. Cloud computing or SaaS is an interesting model for decision services because they must be plugged into a variety of systems, processes, and channels. Taking advantage of the cloud computing model allows decision services to be available everywhere there is an internet connection. The combination of this ease of access and the power of these options to limit the need for up-front software licenses or hardware makes 'decisions-as-a-service' or decisions in the cloud an increasingly interesting option for those adopting BDM.

9.2 Real-time Decision Management

BDM is focused on operational decisions, automated decision making with very low response times, delivering the service in a matter of seconds. Many organizations believe that embedding decision services into real-time systems, such as Web sites or call center applications, means real-time optimization or real-time analytics. In fact, real-time analytics or real-time optimization are rarely required for real-time decisions. Typically, offline analysis of data and construction of models, offline implementation of optimization models, and simulation of transactions are sufficient and more effective.

Note that in the exploration of this thesis, optimal business performance is mostly not about process problems, or even performance management problems, but problems caused by decisioning problems. As James Taylor and Neil Raden put it, "No performance management infrastructure in the world can solve this problem; you will just have a real-time, accurate view of how badly it's going." (Taylor and Raden, 2007)

9.3 Rules as a Service (RaaS)

SOA is the current and next generation of architectural approaches for computer systems. (Rosen et al., 2008) reveals three trends that support this argument:

- First, major software platforms are moving toward SOA.

- Second, major application vendors are reengineering products into discrete services.

- Third, there has been an increase in offerings as Software as a Service (SaaS). Rosen concludes that "the steady march toward SOA is almost inevitable."

9.4 Agile Extended Enterprises

An interesting domain to explore are extended enterprises and how this architecture can be used and implemented when working with different partners, across the borders of the enterprise. Questions arise how the decisions, services, policies and business information can be managed and propagated throughout an increasingly complex environment.

There are several important SOA attributes being highlighted, but foremost is that in an SOA, the business rules and decisions can be extracted and abstracted from the underlying implementation. An advantage it brings is innovation in the process composition, leading to innovation. Traditional monolithic enterprise applications provide not much flexibility as SOA tries to break these boundaries and provide a flexible architecture.

Business processes are often originally designed with the organizational boundaries in mind. However, today's business is organized as a performance network. Information and processes cross multiple organizations. Information and processes are the only things that connect all elements in the performance network. And information needs to lead the way to avoid any surprises in the value chain. Messaging, reports, dashboards, analytics, and other forms of operational and management information need to be available not only in the vertical sense - within the organization and aimed at top management, but should be actively deployed between organizations.(Buytendijk et al., 2009)

10 Summary of Findings

Conclusion

The main purpose of this study was to explore the domain of BRMS and BDMS. The concept of business rules has been used in the last decades and BDM has become more popular in the recent years. It seemed an interesting topic to explore, what value it could bring for companies and how it is able to implement the systems. Organizations are perceived through the lens of the decisions they make and it are those same decisions that eventually lead to the set business objectives. By managing those decisions in a good way, organizations can optimize their value creation. This is what it is all about, value creation.

The main method of this thesis was an exploratory research by reading and analyzing the different resources like (Web) articles, papers, books and online reference material to gain more knowledge. This has been supported by an exploration of the OpenRules BDMS as a case study for the literature study.

The research has shown that there is an emerging interest in BDM and tools to make the theory and models operational. Companies start to notice the value of decisions and their impact on the organization. They want to make better decisions by using the tools to make the discovery, management and analysis of their decisions. The interest in these areas stems from a growing need to enable business agility, being able to react to (or even predict) rapidly changing circumstances and markets.

BDM is also a tool to align business and IT practices as it encourages users to manage and optimize their knowledge in a better and more structured way using several technologies. These include externalizing decisions from BPM and managing them using logical models in a separate logic, applying a SOA and performing analytics to optimize the decision services.

Recommendations

There is a lot to discover in the domain of BDM. It's an emerging and infant domain, researched frequently in the last years. Yet the implementation is still not much found in practice, even BRM is not yet applied widespread as many companies nowadays still not have a decent structured implemented. There are clearly a lot of benefits in the use of business rules, managing business decision and applying a SOA in creating greater business value and agility to react to current markets. Companies can learn a lot from implementing business rules, discovering and learning more about their business and the decisions which are made from day to day.

A recommendation is to take a closer look to the domain of business rules and BDM, applying the practices it step by step. Analyzing your business, defining a consistent business logic and decent management can add a lot of value, increasing the company's agility and maturity. Business people and IT people involved will be better aligned if they collaborate and the software tools available today are promising to enable such a cooperation.

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