

**Methods and Concepts
for
Business Rules Management**

By
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ISBN: 978-90-393-6130-6

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Methods and Concepts for Business Rules Management

Methode en Concepten voor Business Rules Management
(met een samenvatting in het Nederlands)

PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Universiteit Utrecht op gezag van
de rector magnificus, prof.dr. G.J. van der Zwaan,
ingevolge het besluit van het college
voor promoties in het openbaar te verdedigen op
maandag 19 mei 2014 des middags te 4.15 uur
door

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geboren op 26 november 1983,
te Nunspeet

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The work presented in this thesis was supported by the University of Applied
Sciences Utrecht (HU)

Preface

Lao-tzu, a Chinese philosopher, once said that a journey of a thousand miles begins with a single step. Before 2009 I was sure that my journey would lead me into the corporate world. However, during my master thesis I worked with prof. dr. Richard Welke who introduced me to the possibility of pursuing a PhD. After weighing pro's and con's, I decided to change the direction of my journey in favor of pursuing my PhD. So, the goal for the next four years was set.

Although one person gets most of the credits, many people in fact contribute to a dissertation. My general appreciation goes out to everybody who made this PhD study possible. In particular, I would like to thank some people personally.

First of all, I would like to thank my co-promotor Johan Versendaal for his insights and encouragement during the process and answering dozens of questions. In addition, I appreciate the fact that he stayed patient when I sometimes ignored his advice. Next, I would like to thank my promotor Sjaak Brinkkemper for providing me with the opportunity to conduct this research and helped me to realize my scientific ambition.

My general appreciation goes out to everybody at the Hogeschool Utrecht who made this PhD study achievable and possible. Especially, I would like to thank my colleagues Adri Köhler, Pascal Ravesteijn, Eline de Haan, Koen Smit, and Gerritjan Boshuizen. Thanks are also due to Nadia Verdeyen who provided me a research position which was vital for making this PhD study feasible.

Furthermore, I would like to thank the reading committee, Prof. dr. Stef Joosten, Prof. dr. Michael Rosemann, Prof. dr. Hajo Reijers, Prof. dr. Mathias Weske, and Prof. dr. Yao-Hua Tan for their time and effort in reviewing and judging my dissertation. I would also like to express my gratitude to the anonymous reviewers that were involved in reviewing the individual papers that are incorporated in this dissertation. In that respect, I also want to thank the various co-authors of these articles.

Indispensable in the realization of this dissertation were the respondents of surveys and the organizations that provided data. Thank you for your cooperation and invested time in contributing to my research. You gave me the opportunity of validating my findings in practice and for providing valuable new insights. Thanks to all, thank you very much.

This dissertation could not have been finished without the support of my family and friends. I would like to thank you for putting up with my weird schedules, and for your interest in my research. Also thank you for the many distractions when I needed it most. Moreover, I would like to thank my sister and brother in law for their support these past years. Finally, I would like to thank my beloved parents, who have supported and encouraged me throughout the years. Thank you for providing me with everything I needed to make my studies possible and having a happy care free life as well.

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1 BUSINESS RULES MANAGEMENT

To guide and constrain entities, such as individuals, teams and organizations, all kinds of rules are defined. Two of the earliest recordings of rules are the code of Hammurabi in Babylonian history and the Mosaic Law in Jewish history (Harper, 1904). An example of a rule from the Code of Hammurabi is (Harper p.34): “*if a man hold a (debt of) grain or money against a man and he seize him for debt, and the one seized dies in the house of him who seized him, that case has no penalty.*” An example from Mosaic law is (Numbers 9:1-3): “*And the LORD spake unto Moses in the wilderness of Sinai, in the first month of the second year [...] saying, let the children of Israel keep the passover at his appointed season. In the fourteenth day of this month, at even, ye shall keep it in his appointed season: according to all the rites of it, and according to all the ceremonies thereof, shall ye keep it.*” The earliest written recordings of rules that apply to commercial organizations were formulated for guilds in the middle ages (Glendon et al., 2004). Two examples of such rules are: 1) “*I forbid also and order that there shall be [...] no merchant except he be in the guild of Merchants. And if any go out of the Borough of Wallingford, and live of his traffic in the same Wallingford, I command that he shall pay his due to the same burgesses of the guild of Merchants, wherever he may be within or without the Borough.* (Ballard, 1913, p. 210)” and 2) “*No foreign merchant sojourn in the town with his merchandise for the sake of selling his merchandise except for forty days*” (Ballard, 1913, p. 213). Purpose of these rules was to guide the guild and foreign merchants to assert structure and control.

Rules affecting the daily operations of (commercial) organizations with the intention to assert structure and control are called *business* rules. Guilds defined business rules to constrain professional activities, social activities and religious activities for individuals, teams and organizations (Richardson, 2004). Yet such business rules can also be overruled by external business rules. For example, royal charters used to limit power concerning the type of business rules guilds could define (Richardson, 2004). The same applies to organizations today. They define their own internal business rules and have to cope with externally imposed business rules.

External business rules are established by external parties through the creation of regulations and/or standards stating which business rules an organization should comply to. One can distinguish legislation-based sources of rules, and non-legislative sources of rules. Examples of legislation-based rules are European Union regulation (e.g. Basel Regulation and Solvency Regulation),

national regulation (e.g. Child Support Laws and the Health Insurance Portability and Accountability Act), and jurisprudence. Non-legislative sources of rules are standardization organizations (e.g. ISO, NEN, and The Open Group), business partners covenants (e.g. contracts and agreements). An example of an external business rule defined by Basel II (BASEL, 2003) is: *“For natural persons the following information should be obtained, where applicable: 'legal name and any other names used (such as maiden name); correct permanent address (the full address should be obtained; a Post Office box number is not sufficient); telephone number, fax number, and e-mail address; date and place of birth; and nationality.’”* Another (Dutch) example from regulation is article 7 of the Child Support regulation (Algemene Kinderbijslagwet, 2013), which states: *“1. De verzekerde heeft overeenkomstig de bepalingen van deze wet recht op kinderbijslag voor een kind dat: a. jonger is dan 16 jaar en tot zijn huishouden behoort, of b. jonger is dan 18 jaar en door hem in belangrijke mate wordt onderhouden. 2. De verzekerde heeft voor een kind van 16 of 17 jaar slechts recht op kinderbijslag indien: a. de verzekerde heeft voldaan aan de verplichtingen, bedoeld in de artikelen 2, eerste lid, en 4a, eerste lid, van de Leerplichtwet 1969, dan wel daarvan op grond van die wet is vrijgesteld;”* **Internal** business rules are rules that are established by the organization itself. An example of an internal business rules is: *“an order above €10.000 must be approved by a senior manager.”* The difference between internal and external business rules is that in general for external business rules organizations should prove, based on externally imposed criteria, that they have established a sufficient system to enforce the business rules. For internal business rules, there are no externally applied criteria or needs to prove sufficient control on business rules. In this case, organizations can implement their own criteria and create their own system for monitoring.

The increasing number of business rules (among others due to increased legislation), the pace in which they change, the different types of business rules, the necessity to execute business rules consistently and the proof of consistent execution to 3rd parties produce many challenges for organizations (Boyer and Mili, 2011; Graham, 2006). A first challenge is *consistent interpretation* of business rules (Boyer and Mili, 2011; Nelson et al., 2008; Graham, 2006). Consistent interpretation ensures that different actors apply the same business rules, and apply them consistently. This is a challenge as business rules are often not centralized but instead embedded in various elements of an organization's information system. For example, business rules are embedded in minds of employees, part of textual procedures, manuals, tables, schemes, business process models and as hard-coded software applications. Another

challenge is *impact assessment* (Boyer and Mili, 2011; Nelson et al., 2008; Graham, 2006). Impact assessment determines the impact of changes in business rules and their results on an existing implementation. The time to market for full implementation of changes in some cases can be that long that the business rules themselves change (Alles, et al. 2006). A third challenge is *transparency* (Boyer and Mili, 2011; Nelson et al., 2008; Graham, 2006). Business rules transparency indicates that organizations should establish a system to prove which business rules they have applied at a specific moment in time.

To tackle the previously mentioned challenges and to improve grip on business rules organizations search for a systematic and controlled approach to support the discovery, design, validation and deployment of business rules. In literature and industry, such an approach is called *business rules management* (Boyer and Mili, 2011; Ross, 2013; Sinur, 2011; Hilwa, 2012). The aim of the research presented in this dissertation is to analyze and position the phenomenon of Business Rules Management (BRM) and to let both industry and the scientific field benefit. With BRM, being a young discipline, many questions are to be answered; this dissertation aims to find answers to a number of those.

1.1 Motivation

Relevance for practice and society

The first use of the term business rule on record was in the database community in the 80's of the previous century (Appleton, 1984; Graham, 2006). At that time business rules were viewed from a database perspective and defined as (Jellema, 2000, p.1-3) "restrictions that are applied to the state or change of data, also known as data constraints." Instantiations of such business rules are stored procedures, transaction restrictions, format properties, and relationship objects. Yet, although not applying the term business rule, the first recordings of the business rule concept can be traced back to the mid 1960's (Liao, 2004). At that time, expert systems incorporated business rules to inference a specific conclusion based on predefined facts. In addition to the database and expert system perspective, the business rules concept has been applied to multiple other information technology perspectives. Examples are predictive analytics, business process management systems and business rules engines (Bennet et al., 2012). However, among others, Graham (2006) indicates that business rules are not only a technology concept but also a

business concept therefore business rules are more complex than constraints influencing database entries or constraints influencing business process guidance. Consolidation of the business rules concept started in 1995. Ross (1995) published his book *Business Rules Concepts* describing the difference between business rules and implementations of business rules (Graham, 2006, Ross, 1995). To illustrate the difference consider the following business rule example: *"a certified security helmet must always be worn by someone who resides on the workplace."* The implementation of this business rule can vary: 1) a warning sign on the entrance of the workplace, 2) a porter at the entrance who does not allow any man to pass without wearing a security helmet or 3) adding the rule to a work instruction. Further consolidation occurred when in 2000 the business rules manifest was published (Business Rules Group, 2000). This manifest contains 10 articles stating principles of business rules independences. Two examples of articles are article 8: "for the sake of the business, not technology" and article 4: "declarative, not procedural." Article 4 is further decomposed in seven sub-principles. Principle 4.1 states, that "rules should be expressed declaratively in natural-language sentences for the business audience." In 2008, a standard to formulate business rules in natural language is released by the Object Management Group: *Semantics of Business Vocabulary and Rules (SBVR)*. SBVR is the result of a project (Object Management Group, 2003), which stated the following objective: *"to allow business people to define the policies and rules by which they run their business in their own language, in terms of the things they deal with in the business, and to capture those rules in a way that is clear, unambiguous and readily translatable into other representations. Among those representations are presentation forms for business people and software engineers, and executable rules for many kinds of automated systems."* SBVR defines vocabulary and rules to document business vocabularies, business facts and business rules. It defines a meta-model describing different types of business rules. The meta-model divides business rules into two types: operational business rules and structural business rules. Operational business rules are rules that guide action (Object Management Group, 2008). An example is *"The duration of a rental must not be more than 90 rental days."* Structural business rules define business terms and their relationships, for example (Object Management Group, 2008): *"The renter may request a change of car group up to pick-up time, but a car group must always be specified."* SBVR and its underlying meta-model provided a further consolidation of the business rules concept.

Still the field of BRM is not fully established (Graham, 2006; Nelson et al., 2010) and practitioners continue to struggle to phrase BRM. Two observations illustrate this struggle. The first observation is the increasing amount of BRM-related practitioner conferences and the broad range of topics discussed at these conferences. Before 2006, the main and only conference on BRM was the Business Rules Forum. Since 2006, business rules are the main topic of multiple conferences: RuleML (founded in 2007), Rules Fest (founded in 2008), the World Congress on Decision Tables (founded in 2010), and Decision Camp (founded in 2013). In 2012 the Business Rules Forum broadened the scope of its conference and changed its name to the Business Rules and Decision Forum. In 2013, Rules Fest changed its name to Intellifast stating that *"What happened to Rules Fest? Simply put, Rules Fest has evolved into IntelliFest! All the excellent presentations, speakers, tutorials, boot-camps, and networking opportunities are still here...we've just added more features and expanded our scope (Intellifest, 2013)."* The variety in conference names and scope as well as the various name changes per conference, in a relatively short amount of time, illustrate that the field is not fully established. The broad range of topics presented at conferences strengthens this: e.g. usage of BRM-tooling, capturing and analyzing business rules, building pragmatic business rules architectures, and more.

The second observation is the various manners in which industry analysts analyze business rules and BRM. Analysts agree that business rules provide value to a range of existing and emerging applications: process navigation, event recognition, responsive apps, decision optimization, dynamic configuration, and knowledge based systems (Sinur, 2011; Hilwa, 2012; Taylor, 2013). Yet, the way in which analysts approach business rules varies. For example, Sinur (2011) states that decision management is an application of BRM, while Taylor (2013) states that BRM is a subset of decision management. Different reports that analyze and forecast the BRM software market apply the same distinction. Hilwa and Hendrick (2011) and Hilwa (2012, 2013) and Taylor (2013) incorporate decision management software in analysis of BRM software and vice versa. Which minimum functionality a software package should offer to receive the label *BRM suite* or *decision management suite* is still under debate (Morgan, 2002; Graham, 2006, Liou, 2004; Boyer and Mili, 2011). Likewise, the difference between BRM suites and decision management suites is also under debate.

In this research we provide an integral model to assess the application of business rules in an organization. The insights obtained in this dissertation are expected to provide practitioners with knowledge on how to manage and get grip on their business rules and provide them with guidance to shape BRM.

Scientific relevance

The paper "Business rules: the missing link" was one of the earliest scientific publications that mentioned the term business rule explicitly (Appleton 1984). The paper states that (p. 3) "*the key to managing information, then, lies in managing the enterprise or business ontology. This is a role played by Business Rules. Without them, it is impossible to describe or understand, much less manage the enterprise ontology; ergo, without them, today's problems of inconsistent, inaccurate, untimely, and inappropriate information, i.e., information pollution, will continue.*" Since then research has focused, among others, on business rules based systems (Goethe and Bronzino, 1995; Rahman and Hazim, 1996; Plant and Vayssiers, 2000), neural networks (Fu, 1998), rule mining tools (Nelson et al. 2010), business rules architectures (Paschke, and Bichler, 2008; Xiao, and Greer, 2009), the application of business rules in software architectures (Min et al, 1996, Ferrara, 1998; Manuel and Alghamdi, 2003; Ly et al, 2008; Nagi et al. 2008), and database rules (Appleton, 1984; Tanaka, 1992). Although Kovacic's (2004) article entitled "Business renovation: business rules (still) the missing link" states that a lot of work has been done on the business/technology combination, overall, focus of business rules has been on the **information technology** perspective (Kovacic, 2004). This is supported by Nelson et al. (2010), Boyer and Mili (2011) and Graham (2006). That this viewpoint can damage effective and relevant research is illustrated in the neighboring field: expert systems.

The expert systems field (specifically decision support systems research) can be considered a predecessor of business rules technology (Liou, 2004). Despite the fact that decision support systems research "*shows a well-balanced mix of development, technology, process and outcome studies*" Arnott and Pervan (2005) conclude, after studying 1,020 papers, that the expert systems field has lost its connection with industry some time ago and research output with practical relevance is scarce. They list the following reasons for this: almost no theory refinement research is executed, there is poor identification of clients and users, almost no actual case studies are executed, and research is simply focusing on the wrong application areas. A similar trend can be recognized in the young research field of BRM from an **information systems** perspective

(Nelson et al. 2008): “*studies provide beginnings of a business rules research program, but collectively the research often overlooks major steps in BRM [systems] and fails to focus on business rules specific issues and the larger context that rules play in organizations.*” This is strengthened by the fact that the BRM domain does not show a well-balanced mix of research and (Kovacic, 2004; Nelson et al., 2010) “*with so much emphasis towards the technological aspects, we can lose sight of the management of information systems considerations.*” This highlights the need for BRM research from an information systems perspective that takes into account the application of BRM in practice.

The trend shift from researching scientific fields from an information technology perspective towards a broader information systems perspective can also be identified in the field of Business Process Management (BPM). Scientific investigation in the field of BPM includes research on (Van der Aalst et al., 2003, p1) “*methods, techniques, and tools to support the design, enactment, management, and analysis of operational business processes.*” BPM is considered as an extension of the scientific field Workflow Management, which has a focus on researching the application of information technology to automate business processes (Van der Aalst et al., 2003). Both BPM and Workflow Management have an important relationship with BRM. The value proposition of BPM and Workflow Management is to manage and execute an organization’s coordinated value-adding activities. Business rules influence business processes, and underlying activities, by formulating constraints on the design and execution of business rules. Therefore, this research will also focus on the connection between both fields.

This dissertation contributes to the scientific body of knowledge on BRM. By applying grounded theory, case studies and surveys we focus on application areas important to BRM practice while realizing theory refinement.

1.2 Research Theme: Business Rules Management and Separation of Concerns

As indicated above, BRM can be viewed from the information technology field and information systems field (Nelson, 2006, Boyer and Mili, 2011, Nelson et al. 2010). We position the research domain in this dissertation with reference to both scientific fields, yet we provide more emphasis on the information systems perspective. The lens through which we address both fields is *separation of*

concerns. Since BRM in our opinion can be considered as one specific concern in a larger context of concerns.

The concept underlying the separation of concerns has been around for a long time. Scholars like Plato (Lee, 2003) and Smith (1776) already addressed separation of concerns a long time ago. Plato (Lee, 2003) addressed separation of concerns in the context of labor division when philosophizing about the notion of a state: "The barest notion of a State must include four or five men. It will need a farmer, a builder, and a weaver, and also, I think, a shoemaker and one or two others to provide for our bodily needs." Each man focuses on one good he will produce. Since he has to focus on one concern (good), the person will produce it more easily and with better quality than when he needs to focus on multiple concerns. Smith (1776) also addressed the separation of concerns in the context of labor division. He states "as it is by treaty, by barter, and by purchase, that we obtain from one another the greater part of those mutual good offices which we stand in need of, so it is this same trucking disposition which originally gives occasion to the division of labor. In a tribe of hunters or shepherds, a particular person makes bows and arrows, for example, with more readiness and dexterity than any other." Like Plato in 360 BC, Smith (1776) argues that study and work on one subject in-depth, while knowing that one is occupying a part of a larger system, is more effective than addressing all needs simultaneously. The term separation of concerns as a label, within the information technology discipline, is coined by Dijkstra (1982). Dijkstra wrote: "it is, that one is willing to study in-depth an aspect of one's subject matter in isolation for the sake of its own consistency, all the time knowing that one is occupying oneself only with one of the aspects. [...] But nothing is gained – on the contrary – by tackling these various aspects simultaneously", indicating that componentization reduces complexity and enhances comprehensibility. Separation of concerns has become a best practice in the information technology discipline and is the underlying principle of most information technology architectures (Versendaal, 1991 Van der Aalst, 1996; Weske, 2012).

Although proposed information technology architectures vary mentioned authors agree on a general evolution of information technology architecture, as depicted in Figure 1.1. More recently, scholars and practitioners alike propose to separate business rules from the application layer (Graham, 2006; Boyer and Mili, 2011). Thereby expanding evolution of information technology architecture by adding the BRM systems (BRMS) layer, see Figure 1.2. A BRMS can consist of multiple components that provide modeling, simulation, storing, integration,

and administration functionality (Von Halle, 2001). In its most basic form a BRMS consist of two parts: a rule engine part, which acts as an inferencer, and a business rules repository, which acts like a database (Boyer and Mili, 2006). When the BRMS is called upon to solve a specific request it applies (inferences) the business rules stored in the repository to reach a conclusion.

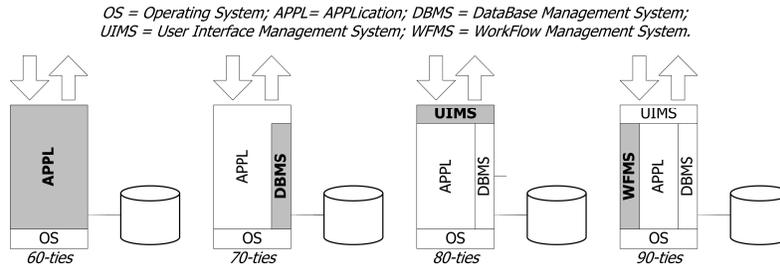


Figure 1.1: Evolution of Information Technology Architecture (Van der Aalst, 1996)

In this context, we note that different types of business rules exist (Ross, 1997; Karadis and Loucopoulos, 2004; Park and Choi, 2004; Jellema, 2000). Business rules that are not applied to formulate operational decisions can restrict and constrain the WFMS, DBMS and UIMS layer. An example of a business rule that constrains the WFMS layer is: "*activity A must not be executed before activity C.*" An example of a business rule that constrains the DBMS layer is: "the number of guests entered must be higher than 2." Therefore, the question arises where to position these type of business rules? To answer this question we need to look beyond the information technology perspective and investigate the information systems perspective.

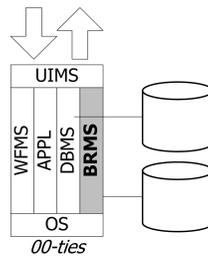


Figure 1.2: Positioning of BRMS in Information Technology Architecture

Similar to the information technology perspective, the ***information system perspective*** also proposes componentization (see e.g. Zachman, 1987; Weske,

2012). One of the earliest componentization-oriented information systems frameworks is proposed by Zachman (1987). The Zachman framework distinguishes two axes: the audience perspective (see Figure 1.3, y-axis) and primitive models perspective (see Figure 1.3, x-axis). As with early information technology architectures, the information systems framework suggested by Zachman does not contain business rules as an independent construct. This raises the question whether business rules are part of an information system? And if so, how do business rules fit in? Are business rules an additional audience perspective or an additional primitive model?

	Inventory Sets	Process Flows	Distribution Networks	Responsibility Assignments	Timing Cycles	Motivation Intentions
Executive Perspective	Inventory Identification / Entity Relationships	Process Identification / Process Relationships	Distribution Identification / Node Relationships	Responsibility Identification / Actor Relationships	Timing Identification / Event Relationships	Motivation Identification / Goal Relationships
Business Mgmt Perspective	Inventory Definition / Entity Associations	Process Definition / Process Associations	Distribution Definition / Node Associations	Responsibility Definition / Actor Associations	Timing Definition / Event Associations	Motivation Definition / Goal Associations
Architect Perspective	Inventory Representation / Entity Attributes	Process Representation / Process Attributes	Distribution Representation / Node Attributes	Responsibility Representation / Actor Attributes	Timing Representation / Event Attributes	Motivation Representation / Goal Attributes
Engineer Perspective	Inventory Specification / Entity Domains	Process Specification / Process Domains	Distribution Specification / Node Domains	Responsibility Specification / Actor Domains	Timing Specification / Event Domains	Motivation Specification / Goal Domains
Technician Perspective	Inventory Configuration / Entity Definitions	Process Configuration / Process Definitions	Distribution Configuration / Node Definitions	Responsibility Configuration / Actor Definitions	Timing Configuration / Event Definitions	Motivation Configuration / Goal Definitions
Enterprise Perspective	Inventory Instantiations	Process Instantiations	Distribution Instantiations	Responsibility Instantiations	Timing Instantiations	Motivation Instantiations

Figure 1.3: Zachman Information Systems Architecture (Zachman, 2013)

Are business rules part of information systems? Zur Muehlen and Indulska (2009) conducted a representational analysis of business rules modeling languages to assert to which degree each specification is capable of representing elements of an information system. For the actual analysis the Bunge-Wand-Weber ontology (Wand and Weber, 1995; Weber, 1997) has been applied, which was developed specifically for the information systems domain. Analysis revealed that business rules modeling languages are capable of representing different information systems constructs, among others: things, properties, statuses, events, and transformations. Current application of business rules in a range of information systems confirms this (Kovacic, 2004). Liao (2004) identified over 25 different types of information systems ranging from psychiatric treatment, production planning, teaching, advisory, alcohol production, DNA histogram interpretation, biochemical nanotechnology, load scheduling, to geosciences that applied business rules. In addition, more recent information systems frameworks also incorporate business rules. However, the actual implementation of the business rule concept varies per framework. The

Department of Defence Architecture Framework (DODAF) recognizes two different types of business rules (Department of Defence, 2010). Firstly, business rules are applied to constrain process flows and secondly business rules are applied to structure decisions. In the Reference Model for Open Distrusted Processing (ITU, 1996) business rules are applied to constrain process flows, while business rules in the Agile Service Development framework are applied to structure decisions (Lankhorst et al., 2012). We conclude that recent frameworks incorporate business rules differently. Which raises the question whether business rules are just a different way of *representation* and thereby an additional perspective in terms of e.g. the Zachman framework.

Is a business rules perspective an additional perspective? The business rules concept is neither an actor nor a role. On the contrary, the business rules concept relates to different audience perspectives. For example the executive perspective of business rules can be law, regulation or organizational policies. An engineer can write business rules in natural language or in a specific information technology format, e.g. Ilog, Corticon, Oracle or Be-Informed. This raises the question whether business rules are an additional primitive model in terms of the Zachman framework?

Are business rules an additional primitive model? The Zachman framework is a classification scheme that consists of primitive models. Primitive models can be modeled independently. At the same time a business rule is (Morgan, 2002) "*a statement that defines or constrains some aspect of the business intending to assert business structure or to control the behavior of the business.*" Business rules can therefore constrain multiple primitive models, as there are inventory sets, process flows, responsibilities, distribution networks, timing cycles and motivation intentions. Therefore business rules are disqualifying as a separate primitive model. Primitive models in the Zachman framework can also be bound together by business rules. For example, the business rule "*the rental duration of a rental must not be more than 90 rental days*" affects and bounds the primitive models 1) inventory set, 2) process flow and 3) timing cycle. Business rules are therefore neither an additional perspective nor an additional primitive model. They are considered constrains on existing primitive models to assert structure and control.

1.3 Research Question

Based on previous elaborations the main research question (MRQ) in this thesis is:

MRQ: How can business rules management be configured and valued in organizations?

This is an explorative research question. As, the BRM field (especially from the information systems perspective) is in a nascent phase (Edmondson and McManus, 2007; Nelson et al., 2010), we, based on discussions in the previous, focus our research on A) provisional explanation of the phenomenon, B) interpreting and introducing constructs and C) proposing relationships between new and existing constructs (Edmondson and McManus, 2007). To cover each focus area two research questions are formulated:

RQ1: Which situational factors influence the configuration of a business rules management solution?

RQ2: How does business rules management influence business process design and execution?

In the remainder of this section the research questions are elaborated.

RQ1: Which situational factors influence the configuration of a business rules management solution?

The first step in answering research question 1 is to define the concept BRM solution. From an information technology perspective this question has been answered (Nelson et al., 2010) and multiple BRM architectures have been proposed (Biletskiy and Ranganathan, 2008; Paschke, and Bichler, 2008; Xiao, and Greer, 2009). From an information system perspective limited research has been conducted thereby limiting consistent reasoning about business rules and BRM. For this we use the concept of problem spaces. A problem space is a set of common design problems for which solutions need to be designed (Simon, 1970; Winter, 2011). We suggest that a BRM problem space is needed that can capture and position instantiations of BRM from an information systems

perspective. Hence the following sub-question (see also chapter 2 of this dissertation):

RQ1.1: What is a problem space for business rules management solutions?

Situational factors affect the BRM problem space and therefore different implementations of a BRM problem space exists. Various research and practices indicate that the notation of 'one solution fits all design problems' is obsolete (Donaldson, 2001; Klesse and Winter, 2007). Methods and techniques need to be engineered to the situation at hand. BRM implementations can for example be affected by the type of business rules that must be enforced or by the type of business rules modeling notation applied. The generic problem space can be used to identify the situational factors that configure the problem space. To identify these situational factors the following sub-question is formulated (see chapter 3):

RQ1.2: Which situational factors describe the design of a business rules management problem space?

After exploring situational factors that influence the BRM problem space in a single organization our research also explores the situational factors that influence an interorganisational BRM problem space. The design, validation, deployment and execution of a set of business rules to realize a specific value proposition can be fragmented over multiple organizations (Peters et al., 2004). For example, for governments a common fragmentation is European Union, State, Region and Local government. But also in industry fragmentation of a problem space occurs (Mercy, 2010). Hence the following sub-question (see chapter 4, where for the construct business rules management *problem space* the result-oriented term business rules management *solution* is used):

RQ1.3: How to configure a business rules management problem space for collaboration optimization?

Research question 1.1 focuses on provisional explanation of the BRM problem space. However, the BRM problem space is one specific concern in a larger information system. A highly related concern is business process management (BPM). The second research question will therefore focus on the relation between BRM and BPM, based on existing BPM literature and constructs. Current research focuses on relating both approaches from multiple viewpoints.

Joosten (2011) and Goedertier and VanThienen (2007) both propose modeling languages to specify business processes in terms of business rules. Ghose and Koliadis (2007) focus on relating both approaches from a risk management perspective. It therefore seems that relating BRM and BPM can be achieved in more than one way and these relationships can be further explored. Hence the following research question:

RQ2: How does business rules management influence business process design and execution?

Governance, risk management, and compliance management are three organizational problem domains that apply to both BPM and BRM (Rikharson et al, 2006; COBIT, 2007; Tarantino, 2008). BPM is applied to reduce the variation in business processes and to control daily operations (Australian Standard, 2004; Tarantino 2008). BRM is applied to define operational risks, policies, and procedures (Marchetti, 2005; Jallow et al. 2007; Ghose and Koliadis, 2007). Therefore, to research the influence of BRM on BPM risk management, compliance management and organizational governance are chosen as domain of application. Hence the following research question (see chapter 5):

RQ2.1: How to integrate risk management and compliance into the (re-)design and execution of business processes?

Research question 2.1 investigates the influence of BRM on BPM in the context of governance, risk management and compliance management. However, BRM and BPM are both applied in broader contexts, for example quality management (Hammer and Champy, 1993; Jallow et al., 2007). Therefore an extension study is executed to see if the business rules categories identified are widely applicable. Hence the following research question (see chapter 6):

RQ2.2: How to categorize business rules such that an integrative relationship is established with the business process development and management lifecycle?

Decisions inherit connections between business processes and business rules. Business processes contain analytical tasks in which decisions are taken. In business process operations, the decisions taken can be structured by business rules. Vanthienen and Snoeck (1993) explored how to model business rules supporting decisions. The main focus of their research was manageability. However, their research only addressed decision tables. We extend this study

by analyzing manageability for multiple business rules languages to express decisions using the following research question (see chapter 7):

RQ2.3: How can transactional sequencing business rules that guide analytical tasks be normalized such that optimal manageability is realized?

1.4 Research Design

The research design and strategy in this dissertation follows the information systems research framework of Hevner et al. (2004; Hevner and Chatterjee, 2010). The framework focuses on information systems / information technology (IS/IT) research and provides a holistic approach and guidelines for research design. Design science research starts with the identification of a problem. Understanding the problem is *"an essential part of building a useful artifact as a design solution. In doing so, it is important to understand the dimensions/design factors, parameters, generality, granularity of problems and possible solutions (Hevner and Chatterjee, 2010)."* To understand the problem information can be derived from the knowledge base or can be identified and delineated from the environment by studying people, organizations, and technology. Which of the two approaches should have emphasis depends on the current maturity of the research field. Similarly, the maturity of the research field also affects the instruments, constructs, methods, data analysis techniques, and evaluation techniques most suitable for the research.

Research field maturity can be classified as nascent, intermediate, and mature (Edmondson and McManus, 2007). Focus of this dissertation on BRM is to large extend on the information systems perspective. As stated earlier the maturity of BRM research from an information systems perspective is in its nascent phase. In this stage of research focus should be on *"provisional explanations of phenomena, often introducing a new construct and proposing relationships between it and established constructs"* (according to Edmondson and McManus, 2007: p. 1158). The type of data collected is qualitative and open-ended, and needs to be interpreted for its meaning. Collection of data occurs through interviews, observation, and obtaining documents relevant to the phenomena of interest with the goal to identify patterns. Data analysis occurs by thematic coding for evidence resulting into a suggestive theory.

Based on the research field maturity the information systems research framework is adapted to fit our needs. Firstly, for BRM the existing knowledge base contains little prior work to build upon. Therefore we choose to indentify the problem space from the environment collecting data through interviews, observation and documents. This results in a framework that provides an overview of BRM solutions in practice (chapter 2). To further explore the BRM problem space, contextual factors that influence design of a BRM solution are explored (chapters 3 & 4). After understanding the phenomena, relationships with mature constructs should be established. In our research, positioning of BRM towards the more mature field of BPM is established. Two studies (chapter 5 & 6) exploring this relationship are presented. The first study presents the relations and concepts involved after which the second study tests the defined concepts by means of a case study and a survey. Additionally one relationship is further explored: business rules formulating decisions that guide tasks in business processes (chapter 7).

1.5 Research Method

In this dissertation, we present several studies that followed a mix method approach (see Table 1-1).

Table 1-1: Research method applied in each chapter

Chapter	Literature review	Grounded theory	Case study	Survey	Mathematical Formalization
2	X	X	X		
3	X	X			
4	X	X	X	X	
5	X		X		
6	X		X	X	
7	X				X

Literature Review

Results of chapters 2, 3, 4, 5, 6 and 7 are based on traditional literature surveys. Standard literature surveys have no specifically defined search process and no explicitly defined data extraction process (Kitchenham, 2009). To introduce the research topics the mentioned chapters contain a traditional literature review.

Grounded Theory

Approaches for chapters 2, 3 and 4 are based on grounded theory. Grounded theory is a method that starts with data collection instead of hypotheses (Straus and Corbin, 1990). Collected data is analyzed in four steps: coding, conceptualizing, categorizing and theorizing. In scientific literature grounded theory is applied in two ways. First grounded theory is applied as research method and secondly it is applied as data analysis and/or data collection method. In chapter 2, both ways of grounded theory have been applied. In chapters 3 and 4 grounded theory is applied as data collection and analysis method.

Case Study

Results of the chapters 4, 5, and 6 are based on single organization case studies. Case study research involves the close examination of organizations, people or software for the purpose of understanding, theory building and theory testing (Yin, 2004). All used case studies concern theory testing. The first case (chapter 2) is used to validate the identified BRM problem space. Secondly a case study approach is used to validate situational factors of the BRM problem space (chapter 4 and 5). The third application of case studies is used to validate the determined business rules categories.

Survey

Results of chapters 4 and 6 are based on surveys. Results of chapter 4 are based on qualitative surveys. In our qualitative surveys response categories are constructed after a survey is completed. Our purpose with this type of surveys is to provide insight into the phenomenon before executing a case study. Results of chapter 6 are based on quantitative surveys. Through surveys we gather empirical data to measure the constructs of our model and test hypotheses.

Mathematical Formalization

Results of chapter 7 are based on mathematical formalization. Mathematical formalization is used to provide a rigorous foundation for artifacts identified. The business rules normalization procedure is mathematically formalized by means of relation theory. This contributed in understanding the artifact as well as validating it.

As previously stated, we followed a mixed method approach. This applies to overall research as well as to individual studies. Mixed method research is

applied to increase confidence in results and artifacts or to provide a more elaborated understanding of a phenomenon than possible when using a single method (Johnson, 2007). The main reason for applying mixed method research in the overall research design is the inherent strength and weakness each individual research method has. For example, grounded theory in general is a method applied to explore phenomena which have not been extensively studied before (Glasser, 1978). The reason for applying mixed method approaches in individual studies varies. In chapter 2 and 4 mixed method research is applied to validate usefulness and application of the created artifact and to generalize findings. Increasing generalization as well as validating mutual exclusivity and usefulness is the purpose of applying mixed method research in chapter 6.

1.6 Dissertation Outline

Following is the outline of the dissertation.

Part 1: Introduction

Chapter 1: Business Rules Management

The research topic is positioned by describing the practical and scientific contribution. The research questions are formulated together with the research approach and methods applied to answer them.

Part 2: The business rules management problem space

Chapter 2: Developing a business rules management problem space framework.

Using a grounded theory approach, a BRM problem space framework is developed, as a means to structure BRM discussions. The final model is based on 94 vendor documents and approximately 32 hours of semi-structured interviews. It shows that the BRM problem space consists of nine separate service systems: 1) elicitation service system, 2) design service system, 3) verification service system, 4) validation service system, 5) deployment service system, 6) execution service system, 7) monitor service system, 8) audit service system, 9) version service system. *Chapter 2 has been submitted for journal publication (Zoet and Versendaal, ND).*

Chapter 3: Configuration of the business rules management problem space.

Using qualitative survey and grounded theory methods data from BRM projects are analyzed. The results show six factors that influence the configuration of the BRM problem space. *Chapter 3 is published in the Proceedings of the 23rd Pacific Asia Conference on Information Systems (Zoet and Versendaal, 2013a)*

Chapter 4: Configuration of the extended business rules management problem space.

In chapter 4, we expand the analysis in chapter three to cross-organizational BRM solutions. Data is collected from a workshop, a survey, and a case study. Results reveal two additional situational factors. *Chapter 4 has been submitted for journal publication (Zoet and Versendaal, ND); an earlier version is published in the Proceedings of the 5th International IFIP Working Conference on Enterprise Interoperability (Zoet and Versendaal, 2013b).*

Part 3: Positioning of business rules management towards business process management

Chapter 5: Business rule categories for risk management

This is the first of three chapters that focus on the relation of BRM with BPM. We study BPM and BRM in the context of risk management, compliance, and governance. This chapter focuses on the role of business rules in the BPM lifecycle. *Chapter 5 is published in the Proceedings of EC-Web 2009 (Zoet, Welke, Versendaal & Ravesteijn, 2009).*

Chapter 6: Business rule categories for business processes

In this chapter, we expand the research in chapter 5 by further exploring five identified business rules categories. Focus of this study is on mutual exclusiveness and usefulness of the business rules categories. Both are tested by means of a questionnaire and an analysis of the Committee of Sponsoring Organizations of the Treadway Commission Framework. *Chapter 6 is published in the Proceedings of the 19th European Conference on Information Systems. (Zoet, Versendaal, Ravesteijn & Welke, 2011).*

Chapter 7: Normalization of business rules for decisioning

In this chapter, we further examine one of the five business rules categories: transactional sequencing business rules. Transactional sequencing business rules are applied to formulate decisions. In this chapter we focus on the management of anomalies such as update, insert en deletion. *Chapter 7 is*

published in the Proceedings of the 22nd Australasian Conference on Information Systems (Zoet, Ravesteijn & Versendaal, 2011).

Part 4: Conclusion and outlook

Chapter 8: Conclusion

The answers to the main research question, detailed and sub-research questions are presented. The scientific as well as practical contribution of the research presented is reviewed. Limitations of the research are discussed and suggestions for further research are described.

2 BUSINESS RULES MANAGEMENT AS A SERVICE: CONFIGURING THE BUSINESS RULES MANAGEMENT PROBLEM SPACE

Business rules are an important part of an organization's daily activities. They define and constrain parts of the organization to assert structure and guide behavior. To cope with changing business rules and to improve grip on current business rules within organizations, a systematic and controlled approach is needed: business rules management. Focus of current business rules management research is information technology; however business rules management is more than mere information technology. The purpose of this paper is to define the problem space (Venable, 2006) of business rules management taking a service perspective, and to specify the underlying service system. To accomplish this goal mixed method research is conducted. The methods applied are grounded theory, a questionnaire and a case study. This results in a validated definition of nine individual service systems (also called service system fragments, for example a fragment to elicitate rules from legislation) and these together can be utilized to effectively configure business rules management.

2.1 Introduction

Business rules are an important part of an organization's daily activities. They define and constrain parts of the organization to assert structure and guide behavior. Take for example, a hospital. From a regulatory and legislative point of view, business rules are used to restrict access to patient information, force hospitals to be more transparent in their decision-making and constrain the incentive system hospitals can apply (Blomgren and Sunden, 2008; King and Green, 2012). Taking a norm-setting perspective these rules are stated for information security; also they prescribe which type of message structures to use for communication and how to store materials (Health Level 7 International, 2013). From an operational perspective these business rules restrict access to laboratories and guide clinical decision-making (Bennett et al., 2012). In general, trends like higher demanding customers, faster changing customer demands, and increased competition force organizations to provide highly configurable products and services; at the same time these organizations

This work is submitted: Zoet, M., & Versendaal, J. (2014). Business Rules Based Perspective on Services: A Mixed Method Analysis.

should remain compliant to external regulation. To cope with this complexity and improve grip on business rules within organizations, a systematic and controlled approach is needed: business rules management.

Business Rules Management (BRM), in the current body of knowledge, is often classified as information technology. This classification attaches great weight to the configuration of software and hardware. Examples of software systems applying business rules are: expert systems, knowledge management systems, business rules engines, case-based reasoning systems, neural network systems, and fuzzy expert systems (Liao, 2004). Current research focuses on the design and development of such rules-based software systems (Goethe and Bronzino, 1995; Rahman and Hazim, 1996; Plant and Vayssiers, 2000) and the application of business rules software in larger software architectures (Min et al., 1996; Ferrara, 1998; Manuel and Alghamdi, 2003; Ly et al, 2008). With so much focus on information technology the BRM domain does not show a well-balanced mix of research and overlooks the context and application of business rules in organizations. Kovacic (2004), Graham (2006), Neslon et al. (2008) and Nelson et al. (2010) argue for research that views BRM as more than mere information technology.

An alternative to the limited information technology perspective is the service perspective (Nelson et al., 2010). The service approach is utilized in multiple scientific domains, for example economic literature, marketing literature, business process literature, information technology literature, and management literature (Vargo and Lusch, 2008; Spohrer et al., 2008). BRM from a service perspective is a value-coproduction and configuration of organizational resources that provide a specific value to their environment (Nelson et al., 2010; Lankhorst et al., 2012). The accumulation of literature from an information technology perspective is not balanced with research that examines BRM from a service perspective (Nelson et al., 2008; Nelson et al., 2010), which takes a broader perspective. In this paper, being a design science instantiation in terms of Hevner et al. (2004) and Venable (2006), we are looking for a service-oriented solution to the so-called *problem space* of BRM. Therefore, to understand BRM from a service perspective, we set out to answer our research question: What is a problem space for business rules management solutions?

The paper is organized as follows. First we illustrate the concepts service and service system. After which we place them in the context of BRM. Section three describes the data collection and data analysis, after which the results are

further elaborated in section four. Section five concludes our paper with discussion and conclusion: the implications for practice and for further study on business rules management are presented.

2.2 Theory

As said, the concept *service*, is utilized in multiple scientific domains. Definitions and conceptualizations vary per domain and per study. Quartel et al. (2007) list seven possible interpretations and perspectives of a service, namely 1) value creation, 2) exchange, 3) capability, 4) application, 5) observable behavior, 6) operation and 7) feature. From the above list Quartel et al. (2007) identify four general characteristics of a service. First, a service involves interaction between two parties, the service user and the service provider. Secondly, the execution of the service between two parties must provide some value to its users. Thirdly, the service concept can be applied to successive abstraction levels reaching from specification to implementation. Fourthly, services are units of decomposition. Decomposition is the process of breaking up larger elements into multiple smaller elements. The goal of decomposition is to create comprehensible elements that do not overlap in functionality and can be studied in isolation (cf. Dijkstra, 1982; Weske, 2012). A service is a black box that can be decomposed into multiple service fragments, see Figure 2.1 . The same applies to the underlying service system. Based on the four general characteristics Lankhorst et al. (2008) and the Open Group (2009) define the link between service and service system as follows: "*A service is a 1) unit of functionality that the organization exposes to its 2) environment, while hiding the 3) service system, which provides [actually delivers] a certain 4) value."* The remainder of this section will first explain the service and the service system concepts, while subsequently projecting them onto the BRM domain.

Literature on services describes different *service* decompositions, for example business services, application services, and infrastructures services (Lankhorst et al., 2008). As a result multiple configurations and decompositions for *service systems* exist. (Fitzsimmons and Fitzsimmons, 1994; Goedkoop et al. 1999; Den Hertog, 2000; Tomiyama, 2001; Nakamura et al., 2006; Vargo and Lusch, 2008; Spohrer et al., 2008). A service system can be a single software application, a specific mix of people, processes and technology. Even entire families, organizations, cities, nations and economies can be defined as a service system (Spohrer et al., 2008). Although different decompositions exist, two general

characteristics can be recognized across studies (Tomiyaama, 2001; Fitzsimmons and Fitzsimmons, 1994; Vargo and Lusch, 2008; Den Hertog, 2000; Goedkoop et al., 1999; Nakamura et al., 2006; Maglio et al., 2009). The first general characteristic is the identification and configuration of operant resources that are utilized to deliver the service. Fitzsimmons and Fitzsimmons (1994) decompose operant resources in supporting facility, facilitating goods, and information. Vargo and Lusch (2008) and Den Hertog (2000) in turn further decompose supporting facility into skills, knowledge, goods, coordination, interaction, and products. An operant resource receiving specific attention is information technology (Den Hertog, 2000; Lusch et al. 2007; Rust, 2004). Rust (2004) argues that information technology is the key driver for acceptance of service design. Rust (2004) additionally states that information technology is an important driver one can use to forecast the development of a specific field, in his case marketing. This statement is supported by research conducted by Den Hertog (2000) and Lusch et al. (2007) and Lusch et al. (2010) who also identified information technology as key innovator with respect to service system design. As a second characteristic: all decompositions include an exchange of input and/or output.

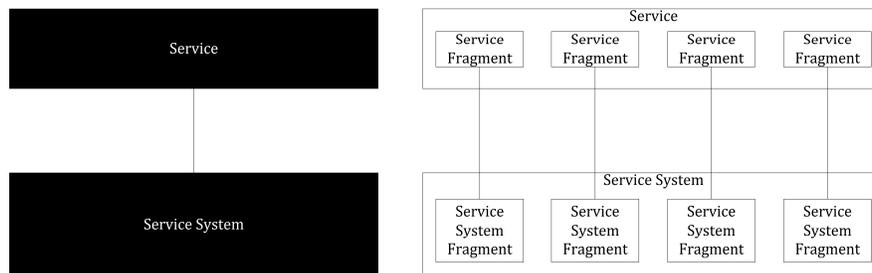


Figure 2.1: Schematic overview of the concepts Service, Service System and Fragment

Value is a quantitative or qualitative benefit the environment, organizations or individuals experience. Related to the BRM domain, Nelson et al. (2010) identified two values services expose to the environment: 1) codified business rules and 2) business rules middleware technology. The customers benefiting from both values are classified as service consumers but no examples or instantiations are given. Other scholars classify the *execution* of codified business rules as the value provided by BRM services (Leon et al., 1999; Lienqueo et al. 1999, Mcoy and Levrany, 2000; Boyer and Billi, 2011). They state that the codified business rules are a means to an end. Examples are

business rules models that calculate the alcohol production (Guerreiro et al., 1997), that guide business processes (Van Grondelle and Gulper, 2011) and that support decision-making for psychiatric treatment (Goethe and Bronzino, 1995). The environments benefiting from previous mentioned examples are production employees in a brewery, government agencies, and psychiatrist respectively. A third group of scholars (Rosca et al., 1997; Xiao and Greer, 2009) recognize multiple individuals benefiting from BRM services, for example business rules modelers, subject matter experts and customers. For these individuals the benefits are codified business rules, validated codified business rules and executed business rules respectively.

The unit of decomposition applied to a service causes differences in the description of added value. A low-degree of decomposition classifies a BRM service as a black box that provides a specific value by execution of codified business rules. A higher degree of decomposition opens the BRM service black box and identifies multiple services each providing their own value. The BRADES methodology distinguishes three services: *acquisition*, *deployment* and *evolution* (Rosca et al., 1995, 1997). The acquisition service realizes the identification and design of a business rules model. Execution of the business rules model is realized by the deployment service. Evolution is a service that evaluates existing business rules models and alters them when needed. Xiao and Greer (2009) propose alternative concept names but identify the same level of decomposition: *elicitation*, *management* and *execution*. Karadis and Loucoplous (2004) also distinguishes between *deployment* and *implementation* but further decompose elicitation in general into *elicitation* and *representation* specifically. The first provides the value of elicited business rules while the second provides the value of properly managed business rules models. Kim et al. (2007) state that business rules services are part of requirements management and decompose the BRM service into: requirements *authoring*, requirements *portioning*, requirements *conflicts detection*, and requirements *conflict management*. Yet, each of the previous decompositions is merely based on information technology reasoning (Kovacic, 2004; Nelson et al., 2010).

Research on BRM is mainly driven from an information technology perspective and does not show a well-balanced mix of research (Kovacic, 2004; Arnott and Pervan, 2005; Nelson et al., 2010). Nelson et al. (2010), who adopted a service perspective on BRM, focused on identifying the actors in a BRM service system. They identified three high-level actor pools: the information technology (IT) department, the business department and a central business rules group

for oversight. They further decompose the IT department and business department into 14 IT staff roles and 14 business staff roles, respectively. However, because of their high-level definition of a BRM service no further decomposition is proposed therefore limiting usability.

Previous research provides conceptual understanding of various BRM services and service system elements. However, these studies in our opinion only addressed a fraction of the issues or factors related to BRM. Knowledge on BRM seems very fragmented and there is no comprehensive solution developed for the BRM problem space. This results in a splintered view of the overall BRM service system that does not show a holistic conceptualization. We feel that this represents a notable gap, and we argue that there is a need to develop a further conceptualization of the BRM service system. This research, among others applying the grounded theory approach, fills this gap and develops a BRM service system framework as a solution to the BRM problem space.

2.3 Research method

Generalization is a major concern when conducting research (Lee and Baskerville, 2003). In general three types of generalization can be distinguished (Lee and Baskerville, 2003): 1) generalization from collected data to constructs and theory, 2) generalization from construct or theory to collected data and, 3) generalization from theory to theory. The goal of this research is to define a generic service system configuration for the BRM service. To reach this goal we first generalize from collected data to a BRM service system construct. After the BRM service system construct is created we want to perform an additional validation thereby generalizing from construct back to theory and data.

To realize the first type of generalization a research method is needed that structures data collection and data analysis with the purpose to realize a construct. Grounded theory is used to do both (Glaser and Strauss, 1967). The purpose of grounded theory is to (Glaser, 1978, p. 125) "explain with the fewest possible concepts, and with the greatest possible scope, as much variation as possible in the behavior and problem under study." To realize the second type of generalization a research method is needed that, based on predefined constructs, can test the application of the BRM service and BRM service system at sites. Case study research is widely applied to realize this goal (Yin, 1994). However, before testing the developed BRM service system at an

actually case site we first want to evaluate it in terms of understanding. To do so we test the construct developed based on the data from which it was derived. For this we developed a questionnaire based on the initial data set. The remainder of this section will first describe data collection for each method after which data analysis for each method is described. Figure 2.2 summarizes the above.

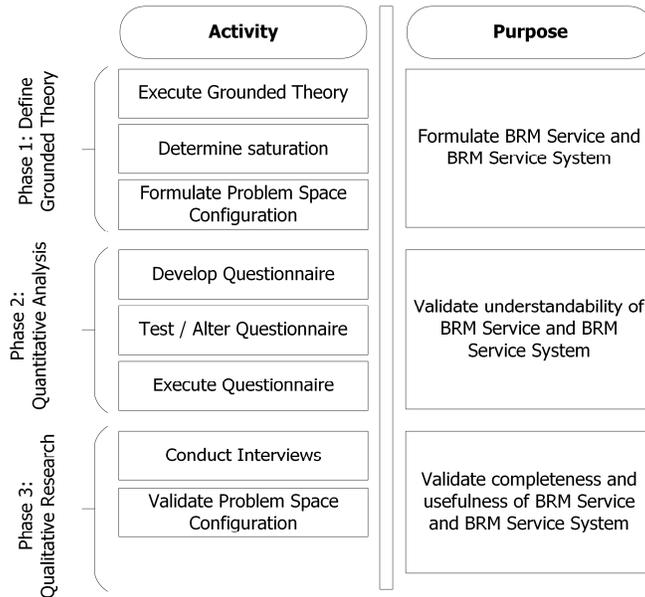


Figure 2.2: Overview of executed research methods with activities and objectives

2.4 Data collection

2.4.1 Grounded theory data collection

Purpose of phase one is to design a BRM service system framework based on collected information from practice. Grounded theory states that the first selection of respondents and documentation is based on the phenomenon studied at a group of individuals, organization, information technology, or community that best represents this phenomenon. Additional data is collected based on analysis of previously collected data (Straus and Corbin, 1990). Two types of organizations are chose for the initial selection of respondents: organizations *applying* BRM and vendors *developing* IT to support BRM.

For the first type of respondents, organizations *applying* BRM, two respondents were selected from the members of the Business Rules Platform the Netherlands (BRPN). BRPN is a community debating and discussing the need and use of BRM. Additional respondents were selected based on information collected during the interviews. This resulted in interviews with four enterprise architects, six business rules architects, three business rules system architects and one subject matter expert. The interviews lasted approximately two and a half hours and followed a predefined protocol. Some interviewees were interviewed during the same time, resulting in a total of 12 interviews. Each interview has been taped.

For the second type of respondents, vendors *developing* IT to support BRM, two vendors were selected from the BRM vendor list provided by the worldwide business rules community. Additional vendors were selected based on information collected during document analysis. This resulted in analysis of 96 documents describing various elements of twelve IT systems that support BRM. Documents analyzed included internal development documents, manuals, architectural documents and white papers. All documents were entered into NVivo to support analysis.

2.4.2 Survey data collection

Purpose of phase two was to test usefulness and understanding of the identified BRM service system framework. To collect data for both measurements a questionnaire has been developed. The questionnaire consists of fifteen pages. The first four pages describe the BRM service system framework. Page five explains the questionnaire and coding scheme. Pages 6 to 15 contain 130 statements, for some examples see Table 2-1.

Table 2-1: Example of questionnaire questions

Number	Construct / Statement	Framework Number
90	<i>Regelspraak</i> , A Dutch Natural Language prescribing patterns to formulate business rules.	
91	<i>Microsoft Excel</i> , to edit and delete business rules.	
92	Gather business rules from legacy applications	

A statement describes a part of the BRM service system framework or an element outside its scope, as depicted in column 2. For each statement the respondent must indicate the component described, depicted in column 3. All 130 statements have been selected randomly from the interviews held and documents analyzed. Additional tweaking has occurred to be sure that all elements of our framework were represented. From a pool of researchers, students and professionals' ten respondents have been randomly selected to complete the survey.

2.4.3 Case study data collection

Purpose of phase three was to validate usefulness and completeness of the BRM service system framework. To collect the data an in-depth case study was executed. Our choice for a case was based on theoretical and pragmatic criteria. The first theoretical criterion was: "the case site should primarily offer services consisting of business rules." The second theoretical criterion was: "No interviews must have been conducted at the site as part of the grounded theory data collection." The only pragmatic criterion was: "site access." Based on these criteria IAX, an authorized insurance broker, had been chosen to conduct the in-depth case study. The financial industry provides a rich context to examine BRM since the main component of insurance products and other financial products are in fact business rules. Also no interview had been conducted at IAX for the grounded theory research. The remainder of this section will describe IAX and the data collection process at IAX.

IAX is an authorized insurance broker, which services over 2000 insurance brokers. Currently, they manage one million plus active insurances that are either IAX private label insurances or insurance products offered through the insurance agencies they broker for. IAX plays a significant role on the insurance market by providing up to date and innovative insurance products and services. This has been recognized within industry as IAX has been awarded multiple innovation awards during the last decade. IAX currently faces two major challenges. First multiple new laws take effect by the end of this year, and upcoming years. Taking into account the current financial status of Europe and its individual countries IAX expects increasing legislation during the coming years. Secondly, customers, brokers, and direct writers want to customize insurance products more rapidly thereby demanding agility that is sustainably, effective and efficient.

In consultation with a director, manager and enterprise architect the evaluation of the BRM service system framework was based on three information sources. The first source of information was interviewing employees involved in the process of developing new services or supportive products. The following roles were chosen to conduct interviews with: enterprise architect, service and product manager, product engineer, product tester, information system tester, IT-manager, loss assessor, and claim assessor. The second source of information was the monitoring of a specific project implementing legislation-triggered changes to an existing service. The process to monitor the project was as follows. An introductory presentation was held for the project team: an introduction to the case study research was given. All internal project meetings from this point on have been recorded and analyzed. Researchers could pose additional questions to the team if elements of the project were unclear. After the project finished, two closedown meetings were held to validate the findings of the researchers. Thirdly researchers had access to documentation and archival records to crosscheck statements made by respondents.

2.5 Data analysis

2.5.1 Grounded theory data analysis

The goal of our grounded theory data analysis was to design a BRM service system that is grounded in practice. To accomplish this goal three cycles of coding were followed: 1) open coding, 2) axial coding, and 3) selective coding (Straus and Corbin, 1990). The goal of open coding is to create a first level of abstraction from analyzed data. This is realized by analyzing data and merge found instantiations to high-level categories. To identify more precise categories and relationship among the high-level categories is the goal of axial coding. In our study axial coding focused on identifying the individual service systems (service system fragments) and the relationships among them. Selective coding was conducted to examine saturation, selecting the core category, relating categories and filling in categories that need further refinement (Strauss and Corbin, 1990). For our study this meant that selective coding was used to enrich the service system fragments found during axial coding. The process and results for each stage of coding are discussed in the remainder of this section.

In open coding the unit of analysis are sentences and individual words (Boyatzis, 1998). First each coder, individually, read and coded available documents. For

examples of open coding in our study see Table 2-2. After the first session of open coding, coded parts were discussed among coders to understand the process and agree on elements that had to be coded. Coders continued in pairs to finalize open coding after which the entire group discussed the coded elements. Open coding resulted in 9769 references classified to five conceptual categories: 1) actors, 2) infrastructure, 3) business rules value proposition, 4) models, 5) services.

Table 2-2: Examples of open coding

Text Fragments	Open Coding
Business users, business analyst, non-technical user, modeler, data-miner, subject matter experts, business rules owner	Actors (involved in BRM)
Test model for correctness, execute business rules, log execution decision service, and build predictive analytics models.	Services (related to BRM)
Predictive analytic model, decision table, decision tree, ontology, domain model,	Models (related to BRM)

The second cycle of coding is axial coding. To support this process Glaser (1978) formulated 18 coding families. He stresses that researchers should not blindly apply each individual coding family to data at hand (Glaser, 2004). The application for a specific coding family must emerge first from the research question and secondly from the data. Purpose of applying coding families in our research was to detail the service system underlying the black box BRM service. We previously mentioned that a service *is a 1) unit of functionality that the organization exposes to its 2) environment, while hiding the 3) service system, which provides [actually delivers] a certain 4) value*. To detail the service system we therefore applied coding families that searched for value chains, end stages, products, phases and processes. We applied the *process* family, *ordering* family and *means-goal* family (Glaser, 1978). Process families are used to identify stages, phases and chains while the means-goal families focus on end stages, purposes, anticipated consequences and products. The ordering family is used to identify temporal ordering and structural ordering between phases, end stages and consequences.

Applying the mentioned coding families created a temporally ordered chain of models (in our case BRM-related models) and values realized through a BRM service. This chain was the basis for decomposition of the BRM service system. As previously mentioned our goal for decomposition was to create comprehensible elements that do not overlap in functionality and can be studied in isolation.

To create the actual decomposition each identified element was translated as the input and output of an individual service system. The rationale behind this is that each element needs to be created by means of a service system fragment and each element additionally needs to be consumed by another service system fragment. The service system fragment therefore fulfills two roles: a provider of input for another service system fragment and a consumer of output of another service system fragment. For example, on the one hand the design service system fragment consumes the output of the elicitation service system fragment. On the other hand the design service system fragment provides the input for the verification service system fragment.

Table 2-3: Business rules service system input, output and added value

Business Rule Service System Fragment	Input	Output	Value
Elicitation	Data source	Cleansed data source	Removal of unnecessary data
Design	Cleansed data source	Actor independent business rules model	Formulating the business rules that provide value proposition
Verification	Actor independent business rules model	Verified actor independent business rules model	Removal of syntax errors in the business rules model
Validation	Verified actor independent business rules model	Validated actor independent business rules model	Removal of execution errors in the business rules model

Business Rule Service System Fragment	Input	Output	Value
Deployment	Validated actor independent business rules model	Executable business rules model (= actor dependent business rules model)	Transform the business rules model to a model that can be read by a specific actor.
Execution	Actor dependent business rules model	Business rules value proposition	Deliver the value proposition of the business rules model
Monitor	Business rules value proposition	Data source	Provide information about the value proposition
Audit	Actor details	Actor details	Provide information about actors in the service system
Version	Data source; cleansed data source; actor independent business rules model; verified actor independent business rules model; validated actor independent business rules model; actor dependent business rules model; business rules value proposition	Data source; Cleansed data source; actor independent business rules model; verified actor independent business rules model; validated actor independent business rules model; actor dependent business rules model; actor dependent business rules value proposition;	Monitor the different versions of information, rules models, and data sources elicited, modeled and executed in the BRM service.

In literature the service system that provides the input and the service system that consumes the output are both called service clients (Vargo and Lusch, 2008; Nelson et al., 2010). If consumption of a service system fragment does not occur the service system fragment does not add value and should be

removed. See Table 2-3 and Table 2-3 for the results of applying the first two families of coding.

The third cycle of coding is selective coding. Selective coding is conducted to examine saturation of categories, selecting the core category, relating categories and filling in categories that need further refinement (Strauss and Corbin, 1990). Saturation occurs when further analysis of data does not provide information or need for additional categories.

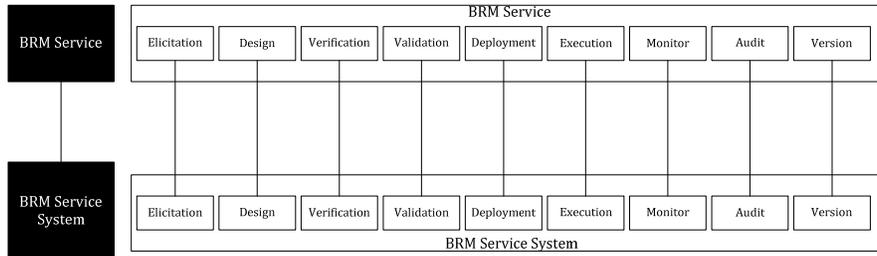


Figure 2.3: Details of the concepts BRM Service and BRM Service System

The previous two cycles of coding identified the nine high-level categories: elicitation, design, verification, validation, deployment, execution, monitor, audit and version. Each of the identified service system fragments were decomposed elements of the overall BRM service system. Therefore, the BRM service system is our core category. After establishing the relationship between the high-level categories and the core category we need to establish the relationship between the high-level categories and the lower-level categories, i.e. service clients and operant resources. The relationship between the lower-level categories and the high-level categories is that each high-level category applies or uses operant resources to deliver its value proposition, see Figure 2.4 . In our case we add operant resources, divided in three sub-types: organizational structure, IT and processes.

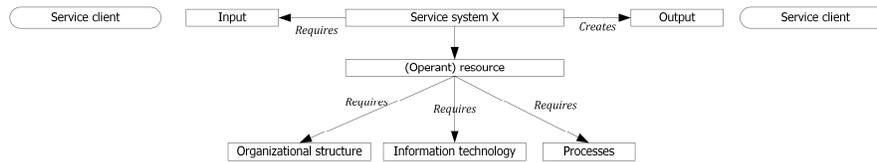


Figure 2.4: Generic BRM service system fragment relationships with operant resources

2.5.2 Questionnaire: data analysis

To validate understandability of the BRM service system framework two inter-rater reliability measures have been used namely 'percent agreement' and 'Krippendorff's alpha'. An inter-rater reliability measure defines the agreement between judges (Krippendorff, 2003). The reason for using a combination of measures lies in the interpretation of both measurements. Percent agreement is widely used but several scholars judge it to be a misleading, inappropriate measure (Krippendorff, 2003). Krippendorff's alpha on the other hand is considered to be a more conservative measure of inter-rater reliability; therefore the combination of both measures gives a reliable view (Krippendorff, 2003).

In addition it is important to understand that a single respondent consistently appoints the same instantiation of the framework to the same part of the framework. For example the same person must assign "gather business rules from legacy applications" and "interview subject matter experts to retrieve information to design business rules model" to the elicitation service system fragment. An appropriate measure for this is Cronbach's alpha (Van Wijk, 2000).

The inter-rater reliability index for the respondents that completed the survey resulted in a 91.22% percent agreement and a Krippendorff's alpha of .813. Both values therefore have appropriate scores as the percent agreement is above 70% and Krippendorff's alpha is above .8 (Boyatzis 1998; Krippendorff, 2003). All Cronbach's alpha values exceed .8 indicating that consensus among answers of individual respondents exists.

2.5.3 Case study: data analysis

Purpose of phase three was to test completeness and usefulness of the BRM service system framework. For our data analysis we applied pattern matching, which is a preferred technique when analyzing case study data (Campbell, 1975; Yin, 1994). Pattern matching is the process of matching data found to predefined patterns. Predefined patterns are based on constructs, their relationships and their logic. Translation of the BRM service system framework to patterns occurred as follows. For each service system fragment patterns were created, see Figure 2.5. Pattern 1 and 2 identify the output of each service system. Resources applied to transform the input to output are identified by pattern 3, 3.A, 3.B, and 3.C. In addition pattern 4 and 5 identified the service clients.

Data was collected and matched to predefined patterns. Strict pattern matching theory states that a solid conclusion can be drawn if the main patterns and underlying patterns are all valid. If one or more patterns are not validated the original pattern has to be questioned (Campbell, 1975; Yin, 1994). The remainder of this section provides illustrative examples of service system fragments within IAX, illustrating completeness and usefulness of the overall BRM service system framework.

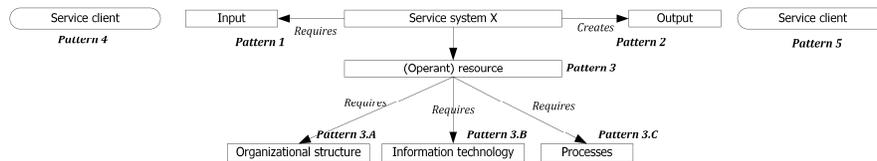


Figure 2.5: Pattern identification template for a service system fragment

The first service system fragment elaborated is the design service system, see Figure 2.6. Information for the creation of 'actor independent business rules models' was retrieved from insurance policy designers. Product engineers promised to develop a business rules model that adhered to the information provided by the policy designers. No formal modeling process existed; junior modelers learned from senior modelers. At IAX, the output of the design service system is always a decision rules model and a business process rules model. The first contains the decision logic to determine 1) if an applicant has a right to receive benefits and 2) the amount of benefit he should receive. The business process rules model contains rules that specify how claims should be handled. Both models are delivered to other product engineers that verify them for errors. No elements have been found that could not be mapped to the design service system thereby indicating completeness.

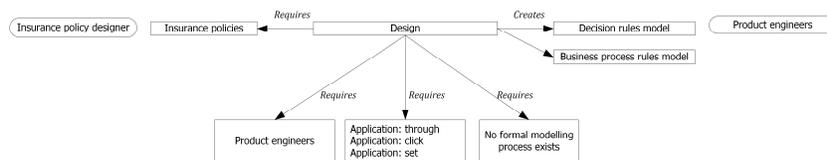


Figure 2.6: Pattern instantiation of the design service system

Product engineers receive feedback if they adhere to predefined grammar-standards from the 'Through'-, 'Click'-' and 'Set'-application. Each software environment has a built-in component that executes syntax checking. However, these software components are still immature. Therefore a viable check for each business rules model is needed. This check is executed by the verification service system, see Figure 2.7. A product engineer checks if the model is correctly written and if so, approves the model. Managers and modelers argue that when the system is mature enough they will only rely on the syntax-checking component in the future, but for the time being a colleague performs a cross-check. Yet, this cross-check is only performed when the rules model is either large or intended for specific (large) customers. No elements have been found that could not be mapped to the verification service system thereby indicating completeness.

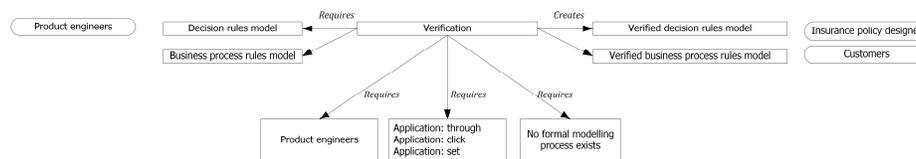


Figure 2.7: Pattern instantiation of the verification service system

Results from the verification service system are input for the validation service system. The validation service system, according to the interviewees, is the most formal service system when developing a new business rules model. Reason for this is that service clients from this service system are internal customers or external customers. Errors can lead to economic losses or loss of reputation. The process is formally described in handbooks and procedures and exists of three or four steps depending on the service and its intended customer. In one of these steps, the business rules model is tested by means of predefined test sets, which are based on information provided by insurance policy designers. Performing a crosscheck is done by internal customers. The external customer also tests and eventually consents on deploying the service to the deployment service system. No elements have been found that could not be mapped to the validation service system thereby indicating completeness.

Each of the nine service systems has been evaluated by the previous described manner. In total 64 patterns (from all service system fragments) have been validated. No elements have been found that could not be mapped to the predefined patterns. Debate occurred regarding eight matched patterns. First

IAX elicits business rules from human and computerized data sources. Elicitation from computerized data sources is supported by information technology while the elicitation from humans is not. Pattern 3.B is therefore valid for only that part of the elicitation service system that deals with computerized data sources. Second, no formal processes exist except for the validation service system and the deployment service system. This led to the discussion whether pattern 3.C for the remaining service system fragments is matched. We argue the processes still exist. If the processes did not exist no work would have been executed and consequently no value delivered.

Application and usefulness of the BRM service system framework was evaluated with the director, manager and enterprise architect. Each indicated that applying the framework provided insight into their daily operations. Their insight can be grouped into two categories. First the framework provides insight in the current state of individual service systems and underlying operant resources. For example, in this way the lack of formal process descriptions for seven of the nine service system fragments can be identified. According to the respondents this provides a roadmap for further improvements. Secondly, the framework provides insight in the relationship between the individual service systems and their value propositions. This allows for better decisions in relation to the instantiations of specific service systems. For example, the validation service system with respect to a decision service for customers is formally defined. The execution of this particular service system fragment is closely monitored. However if we would evaluate the validation service system for (the service of) internal risk rating calculations the service system fragment has a different instantiation. In the latter situation, for example, the business rules model is validated by data sources yet no human experts formally test the model. Our framework allows the comparison of different instantiations of an individual service system.

2.6 Further elaboration

This section provides a further detailed description of each individual service system.

Service system fragment: Elicitation. Added value of the elicitation service system is the removal of unnecessary data from tacit and explicit data sources. To realize the added value the following organizational roles are involved:

subject matter experts and business rules analysts. Analysts understand which data is needed to create the business rules model and know how to retrieve the business rules model from data sources. The subject matter expert provides data needed to formulate the business rules model. Output is provided for the design service system.

Service system fragment: Design. Added value of the design service system is designing an actor independent business rules model from data provided by the elicitation service system. To realize the actor-independent business rules model an author or architect designs the model. Output includes a business rules model to achieve the proposed value proposition. Actors executing the process are: business rules analysts, business rules architects, and subject matter experts. Guidance elements include a business rules factoring protocol and language specific design protocols. Guidance elements are elements that provide structure or guidance to the executed processes.

Service system fragment: Verification. This service system fragment searches for errors, exceptions, inconsistencies and omissions in the rules model's semantics and syntax. Input includes the output from the design service system. Output includes a semantical and syntactical error-free business rules model to achieve the proposed value proposition. Actors executing the service fragment are: automated information systems and/or peers of the actors that execute the rules design for a specific model. Guidance elements include business rules language modeling notation grammar.

Service system fragment: Validation. This service system fragment checks for errors and inconsistencies in the application of the rules model. Input includes the output from the verification service system. Output includes an error-free business rules model to achieve the proposed value proposition. Actors executing the process are: automated information systems and/or subject matter experts. Guidance elements include various test cases that represent real-life situations that the rules model must handle during execution.

Service system fragment: Deployment. This service system fragment transforms validated actor-independent business rules models to actor-dependent business rules models. Input includes output from the validation service system. Output includes business rules models tailored to the individual needs of the executing actor. Actors executing the process are: automated information systems and/or information technology experts. Guidance elements

include architecture principles and the notation grammar of the actor-dependent business rules models.

Service system fragment: Execution. This service system fragment delivers through its execution- the actual value of the business rules model. The actual value proposition varies per organization. To realize the added value human or computerized actors execute the rules model.

Service system fragment: Monitor. This service system fragment observes, checks, and keeps record of executed actor-dependent business rules models. Input includes the output from the execution service system. Output includes information that helps to understand the execution of the business rules and is useful for suggesting improvements. Actors executing this service system fragment are: automated information systems and/or information technology experts. Guidance elements include architecture principles.

Service system fragment: Audit. The added value of the audit service system is determined by the collecting of information on actors creating, editing, removing or adapting information in the overall BRM service system. Each service system fragment provides input. And output is provided to the auditor or project manager who wants to verify information related to changes in data, information or models.

Service system fragment: Version. The added value of the version service system is defined as keeping track of different versions of data, information, and rules models in the overall BRM service system. This is generally realized by assigning unique version numbers or names to unique states of data, information, and rules models in the overall BRM service system.

2.7 Discussion and Conclusion

The development, update or replacement of a service concept and underlying service system has become an important concern (Den Hertog, 2000; Menor et al., 2002). Innovation of services and service systems is a new experience in one of six dimensions: a new service concept, new customer interaction, a new value system or business partner network, a new revenue model, and a new organizational or technological service delivery system (Den Hertog, 2010, p. 19). To support this activity a framework and supporting tools need to be

defined and developed. Yet, before development can commence, an understanding of the service and service system is needed. The process from conception to consumption of a specific business service needs to be understood. This process varies depending on the type of service and underlying service concepts. Business services are treated and studied in aggregate. No distinction is made between new businesses, new business models, a new product line or an individual service system thereby limiting the predictive and external validity of service design research findings (Menor et al., 2002).

In this research we defined BRM as a service. Our research provided a service-oriented solution to the associated BRM problem space and decomposed the high-level BRM service system into nine service system fragments. This increases understanding of the BRM service system from a scientific as well as a practical viewpoint. Additional research can now be mirrored onto our framework and can put results into perspective. From a practical perspective our study provides organizations with a diagnostic tool for identifying and describing their BRM service system. It offers a framework that can structure thinking about the solution to be implemented.

Several limitations may affect our results. The first limitation is the number and type of BRM implementations analyzed during the grounded theory study. While saturation occurred when analyzing organizations that implemented a BRM service system, this may have been caused by the fact that all implementations were based in the Netherlands. The correct way to assess the generalizability of a theory is through the use of deduction (Lee and Baskerville, 2003). Grounded theory is based on induction and deduction. The case study performed is additional deductive reasoning. Still, to further generalize our defined solution of the BRM problem space, deductive validation outside the current units of analysis should be conducted; we note that such a deductive validation is outside the scope of this paper.

This research investigated the BRM problem space and its solution by defining the underlying BRM service system with the purpose of answering the following research question: *what is a problem space for business rules management solutions?* To accomplish this goal, we conducted a sequential mixed method research applying grounded theory, a questionnaire survey and a case study. Grounded theory was applied to formulate the BRM service system. After which its understandability was tested by means of a survey. To further generalize

results a theory testing case study was executed. This analysis eventually revealed nine BRM service systems fragments: elicitation, design, verification, validation, deployment, execution, monitor, audit and version. Each individual service system exists of an input, output and (operant) resources. The operant resources can be further defined in organizational structure, information technology and processes. In summary, our purpose in this paper was to define the BRM service system. Through mixed method analysis we contributed to this goal.

3 CONFIGURATION OF THE BUSINESS RULES MANAGEMENT PROBLEM SPACE

Business rules management solutions are widely applied, standalone or in combination with business process management solutions. Yet scientific research on business rules management solutions is limited. The purpose of this paper is to define the business rules management solution problem space. Using contingency theory and relational theory as our lens, we conducted a qualitative study on 39 business rules management solutions. The range of data sources included interviews and document analysis. From the qualitative study six situational factors have been defined to classify the business rules management solution space: 1) value proposition, 2) approach, 3) standardization, 4) change frequency, 5) n-order compliance, and 6) integrative power of the software environment. The six factors can be clustered in three structures 1) deep structure, 2) physical structure and, 3) organizational structure. The classification of the problem space provides a framework for the analysis of business rules management solutions.

3.1 Introduction

Business rules management and business process management both study the management of activities and decisions. The difference between the two is the adopted viewpoint. Business process management (BPM) adopts an activity/resource viewpoint while business rules management (BRM) adopts a knowledge/guideline viewpoint (Zoet et al., 2011). The last decade an increased interest to integrate the two viewpoints has emerged in scientific as well as professional literature. Research to do so has been and is currently executed in the domain of business process and business rule formalization, classification, articulation, and technical interoperability (zur Muehlen & Indulska, 2010). We are in agreement with Rosca and Wild (2002) and Nelson et al. (2010) that a broader view of integrating business processes and business rules should be taken. Thus, not only focusing on the technical aspects but also connecting both problem spaces and management practices. BPM research already explicitly focuses on management practices and the definition of the business process management problem space (Bucher & Winter, 2010). However, research focusing on management practices for BRM is limited (Arnott

This work was originally published as: Zoet, M., & Versendaal, J. (2013A). *Business Rules Management Solutions Problem Space: Situational Factors*. Paper presented at the Pacific Asia Conference on Information Systems, Jeju.

& Pervan, 2005; Nelson et al. 2010; Rosca & Wild, 2002). Consequently, the problem space 'business rules management solutions' needs to be defined before connecting the two fields from a management perspective.

A business rule is (Morgan, 2002) "a statement that defines or constrains some aspect of the business intending to assert business structure or to control the behavior of the business." A business rules management solution (hence BRMS) enables organizations to elicitate, design, manage and execute business rules and is a co-creation of eleven service systems (Zoet & Versendaal, 2012) namely 1) the monitoring service system, 2) the execution service system, 3) the deployment service system, 4) the verification service system, 5) the validation service system, 6) the design service system, 7) the improvement system, 8) the mining service system, 9) the cleansing service system, 10) the version service system, and 11) the audit service system. Each individual implementation of a BRMS is a specific instantiation of previous mentioned service systems.

BRMSs are commonly addressed as singular problem-oriented, meaning that a specific BRMS is designed to solve one specific problem (Liao, 2004; Wanger et al., 2002). Yet, previous research has shown that different BRMSs have a common design problem. A common design problem indicates that common problem classes, for which design solutions can be created, exists (Simon, 1970; Winter, 2011b). Winter (2011b) defines a problem class as a set of similar design problems. A problem space can contain one or more problem classes. For example, decision management and process guidance can be problem classes of the problem space BRMS. An instantiation of a specific problem class in a specific organization is defined as a design solution. In the BRMS problem space the design solution is a specific configuration of the earlier mentioned eleven service systems.

Both problem spaces and design solutions are subject to situational factors (Winter, 2011b). Situational factors describe the context in which an IS artifact or organization has to operate such that the deployed artifact fits the context of the environment. Research identifying situational factors is executed, among others, in software product management (Bekkers et al., 2008), business process management (Bucher & Winter, 2010) and, enterprise architecture (Klesse & Winter, 2007). Research focusing on situational factors affecting business rules in general and the BRMS problem space specifically, to the knowledge of the authors, is absent. This article extends the understanding of

BRMSs by addressing the situational factors that characterize different problem classes. With these premises, the following research question is addressed: *"Which situational factors describe the design of a Business Rules Management problem space?"* Answering this question will help organizations better understand the design and management of BRMSs.

The paper is organized as follows. First, we start by looking at contingency theory and relational theory, which we consider the fundament for our research. After which the relationship between problem classes, design situations, and situational factors is explained. Section three, describes the collection and analysis of 39 BRMS implementations. After which the results of the data analysis, the identification of six situational factors to classify the BRMS problems, are presented in section 4. Section 5 theorizes and compares the results of our research to previous research. Furthermore the limitations and contribution to theory and practitioners are presented. We conclude and summarize our research in section 6.

3.2 Literature review

The core proposition of contingency theory is that a fit between situational factors and organizational structure of an enterprise leads to performance while a mismatch leads to lack of performance; indicating that the effect of one variable by another depends upon a third variable (Donaldson, 2001). Empirical evidence supporting and rejecting this theory have both been found and therefore some scholars heavily criticize its validity (Pfeffer, 1997). Still the central idea that fit positively affects performance is accepted in the scientific community (Strong & Volkoff, 2010; Winter, 2011a). When constructing solutions, methods or information systems situational factors should be considered to achieve a proper fit between the constructed solution, method, information system and the environment in which they are applied. Situationality is the similarity or dissimilarity of two or more problem classes expressed in terms of situational factors. Relational theory (theory of networks) state that systems, organizations, artifacts are differentiated by reduction in degrees of freedom taking into account the different levels in which freedom can occur (Economides, 1996; Lin, 1999). Thus situational factors from a relation theory viewpoint reduce the degree of freedom of a problem class. Therefore problem classes can be viewed as the product of unique, relational ordered, situational factors.

To explain the difference between problem spaces, problem classes, design situations and situational factors we adopt the Chinese house example by Winter, see Figure 1.3. The problem space depicted is building a Chinese style house. This problem space is divided into problem classes by situational factors. For example the foundation and framing of the house reduce the degree of freedom thereby specifying problem classes. Problem classes again can be further specified by means of situational factors, representing the different levels in which freedom can occur. If no further reduction in freedom can occur different problem classes for building the Chinese Style house have been defined. Each problem class now represents a design situation that can be built. The instantiation of the actual design situation itself is also influenced by situational factors. For example if the problem class Chinese House A states that the structure and roof of the house must be circular it doesn't state anything about the material used in the actual instantiation. This can differ per house build. House number one can be build with bricks while a second house can be build with wood. Material in this case is a situational factor influencing the actual construction of the house. Situational factors affecting the problem space are the minimal number of situational factors necessary to classify a specific problem class, which we define as the classification freedom of the problem space. Thus, situational factors reducing the freedom of a problem class exist in all instantiations of design situations whereas situational factors affecting solely design situations are not.

Design solutions addressing a specific BRMS problem space are a configuration of the earlier mentioned eleven service systems. A detailed explanation of each service system can be found in (Zoet & Versendaal, 2012). However to ground our research method a summary is provided here. To deliver the value proposition of a BRMS, business rule models need to be design. Before a model can be designed data sources need to be mined for information. Data sources can be sources such as human experts, documentation, laws, and regulation. The 1) mining service system contains processes, techniques and tools to extract information from various sources. In some cases the data sources have to be cleansed to accomplish the desired mining effect. Data that intervenes with proper mining or design activities is removed from a data source by the 2) cleansing service system. After cleansing and mining, the non-platform specific rule model is created within the 3) design service system. Additionally an 4) improvement system exists which contains processes, techniques, algorithm, and tools for optimization and impact analysis of the designed rule model.

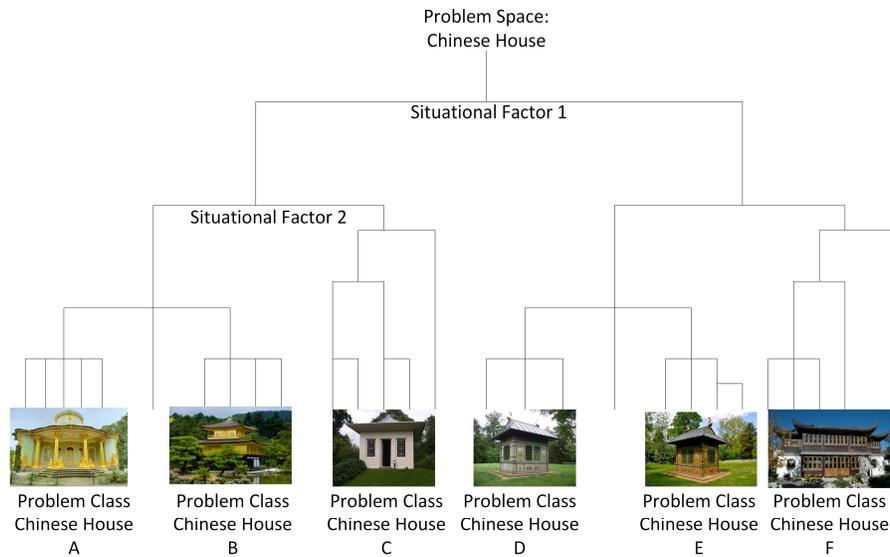


Figure 3.1: Chinese House Example

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After the rule model is created it is checked for two types of errors: A) semantic / syntax errors and B) errors in its intended behavior. The first type of errors are removed from the rule model by the 5) verification service system; the latter by the 6) validation service system. The 7) deployment service system transforms the validated and verified models to a platform specific rule model. The platform which executes the business rules can be human or automated. A platform specific rule model can be source code, handbooks or procedures. Execution of business rules is guided by a separate service system: 8) the execution service system. It transforms a platform specific rule model into the value proposition it must deliver. Deployed business rules are monitored for proper execution. The 9) monitoring service system collects information from executed business rules and generates alerts when specific events occur. This information in turn can be used to improve existing rule models or design new rule models. All service systems provide output to two management service systems: 10) the audit service system and 11) the version service system. Data collected about realizing changes to specific input, output and other service system elements are registered by the audit service system. Examples of registered elements are: execution dates, rule model use, rule

model editing, verification and validation. Changes made to the data source, platform specific rule models, non-platform specific rule models and all other input and output are registered by the version service system.

3.3 Research method

3.3.1 Research design

The goal of this research is to identify the situational factors that characterize the BRMS problem space. To accomplish this goal a research approach is needed that can 1) identify situational factors, 2) identify similarities and dissimilarities between situational factors, and 3) identify the similarities and dissimilarities of situational factors between cases. The first two goals are realized by applying grounded theory. The purpose of grounded theory is to “explain with the fewest possible concepts, and with the greatest possible scope, as much variation as possible in the behavior and problem under study.” Grounded theory identifies difference and similarities by applying eighteen coding families. However, this does not provide a structured comparison of the identified situational factors across cases. A technique specifically engineered to inspect cases for similarities and differences is ordinal comparison based on Mill’s method of agreements and difference (Mahoney, 1999). Mill’s method states that the cause of a phenomenon is the characteristic or combination of characteristics found in each case (Mill, 1906). Translated to our situation this means that the minimal set of situational factors needed to describe the BRMS problem space are the situational factors present at each BRMS. Therefore Mill’s method in combination with grounded theory is adopted for this analysis.

3.3.2 Data collection

The concurrent data collection and analysis during the grounded theory study included the analysis of 63 project documents and approximately 18 hours of semi-structured interviews. In concurrence with the grounded theory methodology (Straus and Corbin, 1990) the interviewees as well as the projects have been selected based on concepts under investigation, their properties, dimensions and variations. The first selection within a grounded theory research is based on the phenomenon studied and a group of individuals, organizations or communities that best represent this phenomenon (Straus and Corbin, 1990). For example if one wants to study the work of nurses, one goes to a hospital or clinic. In our case we went to the Business Rules Platform the Netherlands; a community debating and discussing the need and use of business rules based

services. From their 454 members we selected two organizations to start conducting interviews and collecting project documentation. The unit of analysis is a single BRMS, implying that one organization can contribute multiple units of analysis. To contribute cases, consultancy agencies, vendors or system integrators must have advised on or implemented multiple BRMSs, preferably in multiple industries. For all other organizations the criterion is that they implemented one or more BRMSs and preferably also applied changes to the specific solution over time. In total we analyzed 39 BRMSs, for details see Table 3-1.

Table 3-1: Number of BRMS analyzed per industry

Industry	Number of BRMS
Financial	11
Medical	4
Transport	1
Government	19
Remainder	4
Total	39

Data for this study were collected through written documentation (vision documents, project documentation, internal communication, project presentations and evaluations), and semi-structured interviews with 15 informants at various organizations. Semi-structured interviews were conducted with four enterprise architects, six business rules architects, three business rules system architects and one subject matter expert from government and industry. The interviews on average took about 2,5 hours. During the interview sessions respondents were first asked to describe a specific BRMS based on the eleven service systems and their characteristics. During the second part they were asked to indicate changes over time for the same BRMS. The last part of the interview focused on changing specific implemented elements for a specific service system and asking respondents to indicate the impact on other service system elements. All interviews were recorded.

3.4 Data Analysis

Data analysis was conducted in several iterations following three cycles of coding namely (1) open coding, (2) axial coding, and (3) selective coding (Straus & Corbin, 1990) and one cycle of ordinal comparison, and narrative analysis. During the first cycle, text fragments, either individual words or

sentences, have been classified as situational factors. Due to space limitations the complete matrix is not be added to the paper. A snapshot of the situational factors matrix has been added instead, see Table 3-2. After open coding, axial coding has been applied. During axial coding relationships between categories must emerge. Relationships can be identified by applying eighteen coding families (Glaser 1978).

Table 3-2: Situational Factor Matrix

Text	Situational Factor	Inductive	Deductive
The roles needed for the execution of this project are: end users to validate the business rules, lawyers to validate business rules. Rule analysts to elicitate and the design the business rules. Testers to validate and veriflicated the business rules. Architects to validate the architecture principles.	End users	End User	
	Lawyers	Lawyer	
	Rule analyst	Rule analyst	
	Testers	Tester	
	Educators	Educator	
	Architects	Architect	
	Programmers	Programmer	
In this project the current business rule models, depicted in Microsoft Word and Oracle Policy Automation, are translated to The Decision Model.	Word	Software	
	The Decision Model	(1) Modeling Notation / (2) Non-Standard Modeling Language	
	Oracle Policy Automation	(1) Modeling Notation / (2) Non-Standard Modeling Language	
Our recurring propositions for BRMSs are self service processes, customized advice, scheduling and granting.	Value Proposition		Self Service Processes
	Value Proposition		Customized advice
	Value Proposition		Scheduling
	Value Proposition		Granting

This process requires inductive as well as deductive reasoning and data collection. Inductive reasoning has been applied to reason from concrete factors to general situational factors. For example, a project report from a government agency stated that two modeling notations are applied 1) The

Decision Model Notation and 2) Oracle Policy Automation Modeling Language. During open coding both were coded as situational factor. Iterating between open coding and axial coding both were re-coded to modeling languages. Applying the eighteen coding families, the type family identified a difference between standard modeling language and non-standard modeling language. Since both modeling languages are not (yet) an accepted standard both were re-coded to non-standard modeling language. Reasoning from general factors to case instantiations has been applied when respondents argued on specific situational factors occurring in multiple cases. For example, consultancy firm X stated that value proposition is a situational factor that affects a BRMS. For each case, the value proposition was described: 1) self service processes, 2) customized advice, 3) scheduling and 4) granting. Value proposition at first glance is a category that should emerge, iterating between open coding and axial coding. Therefore open codes were reviewed to identify value propositions.

Next, all situational factors per individual case have been transformed to columns in an ordinal comparison table. An ordinal comparison table exists of mutual exclusive categories, in our case situational factors, that either are present (1) or absent (0), see Table 3-3. Due to space limitations the complete ordinal comparison table could not be added to the paper, a snapshot has been added instead. The rows depict the cases analyzed. For each case the presence or absence of the situational factor has been depicted in the table.

Table 3-3: Ordinal Comparison Situational factors

Case	Situational Factor					
	Value Proposition	Development Philosophy	Rule Analyst	Architect	Change frequency	Nth Situational Factor
Financial Case I	1	1	1	0	1	0
Financial Case II	1	1	0	0	1	0
Financial Case III	1	1	1	0	1	1
Government Case I	1	1	1	0	1	0
Government Case II	1	1	1	1	1	0
Government Case III	1	1	0	0	1	0
Government Case IIII	1	1	1	1	1	1

3.5 Results

In this section the six identified situational factors of the problem space are presented, see Figure 3.1. The situational factors have been structured along the dimensions of the ontological foundations of information systems framework originally proposed by Weber (1997) and extended by Strong and Volkoff (2010). The framework is divided into four sections: 1) deep structure, 2) organizational structure 3) physical structure and, 4) surface structure. Deep structure elements are subjects that describe real-world systems, their properties, states and transformations (Weber, 1997). Three situational factors affect the deep structure: 1) value proposition (VP), 2) approach (A) and 3) standardization (S). Organizational structures are the roles, control and organizational culture represented within organizations or within solutions (Strong & Volkoff, 2010). Two situational factors affect the organizational structure: 4) change frequency (CF) and 5) n-order compliance (NC). Physical structure elements describe the physical technology and software in which the deep structure is embedded (Weber, 1997). One situational factor affects the physical structure: 6) the integrative power of the software environment (IP). Surface structure elements describe the interface between the information system and the users. No situational factors have been identified that affect the surface structure.

3.6 Reduction of Freedom: Deep Structure Situational Factors

The *first situational factor* is the 1) *value proposition* realized. This results in a reduction of freedom in terms of subjects modeled. This in turn results in a reduction of applicable processes and output subjects for each of the eleven service systems. A business rules analyst described the reduction of freedom as follows:

“When the application of the business rules must be able to guide business processes they must specify input constrains, output constraints and sometimes sequence. When the application of the modeled business rules must be able to make a decision they must specify condition and conclusion. The manner in which both are designed, veriflicated, validated and deployed differs. As well as the languages in which we model them; BPEL and OPA [modeling language].”

Analysis of the 39 BRMSs indicated a large number of different value propositions and corresponding subjects modeled. For example, guidance of process execution, guidance of documentation creation, granting, guidance of interactive web documents, monitoring of actions, decisioning, and configuration of personal advice to name a few. Collected data allows defining detailed subcategories of value propositions and subjects modeled. However, after debate we decided to define generic value propositions and not yet detailed subcategories.

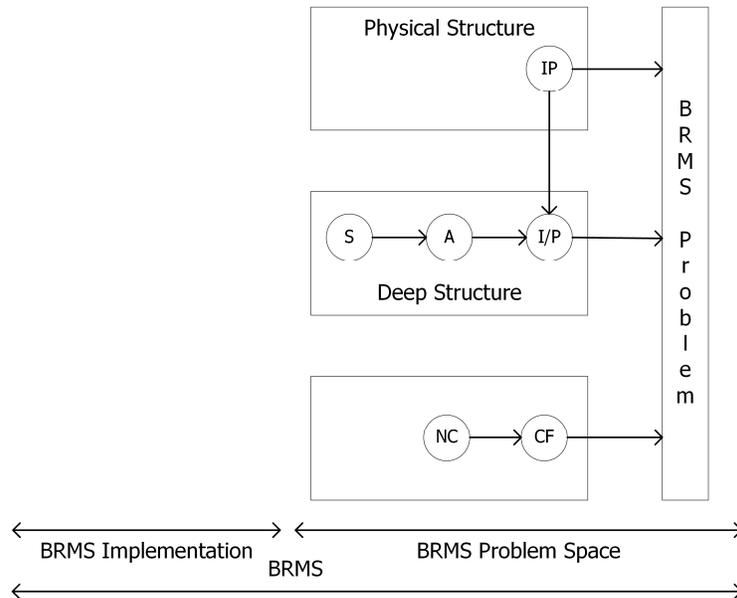


Figure 3.2: Casual Linkage Situational Factors

Therefore, in line with current literature, we define three different values for the value proposition situational factor: A) guidance (constraint), B) communication and C) decisioning. *Guidance elements* describe boundaries, borders or limits with regard to the behavior of business entities. This value proposition applies to a broad range of application areas and business rule statements. Business entities can be anything of value to the business for example databases, human resources, interaction elements and processes. The value proposition *communication* is realized by describing a business entity, its characteristics and/or relationships with other business entities. Definitions of actual business entities can be proposed: for example a driving license is an

authorization for the bearer to drive a specified motorized vehicle. Therefore a driving license belongs to a person. *Decisioning* describes conditions evaluating business facts leading to a conclusion. The application of this statement depends on the application area. When applied to assess decisioning business rules are used to formulate a decision. However, when decisioning is applied to monitoring the business rules are used to formulate norms. The *second situational factor is 2) approach*. The choice for a specific approach determines the model abstraction needed. This in turn results in a reduction of applicable service systems for the BRMS. Our analysis revealed three different values for approach: A) IT-oriented value, B) business-oriented value, and C) balanced value. The IT-oriented value emphasizes on enactable platform specific rule models. An enactable model is a model that can be executed by physical hardware or software. The output of the service systems are IT-related products such as technical design documents and functional design documents. On the other hand the business-oriented value focuses on realizing non-platform specific rule models. Business rule models realized with this value serve mainly for simulation and communication. The balanced value bridges both worlds. In the latter type the business units develop the non-platform specific rule model while the IT department translates the model to enactable platform-specific rule models. Nelson et al. (2010) identified the same values, however, viewing them through a maturity model lens. Where the IT value is classified as the lowest level and the business value / balanced value is classified as the highest. Although we identified BRMSs following the same shift in problem class, the other way around also is recognized. An architect and business analyst explain:

“Business Rules are the single point of knowledge within an organization. Only a limited number of business people maintain the business rules. The rules are directive for each action taken and every form of communication inside and outside the organization. In our case the information department might use the business rules as input but they do not create business rule model themselves. Long term strategy [5- 10 years] might allow this, but currently: no”

“We started our business rules approach at the product engineering department. When the process was mature enough at the business side we started to bridge the gap to the IT department”

The *third situational factor* is defined as 3) *standardization*. Analysis identified two different values: A) standardized modeling language or B) non standardized modeling language.

3.7 Reduction of Freedom: Organizational Structure Situational Factors

The *fourth situational factor* 4) *change frequency* of business rules affects the organizational structure of a BRMS. Change frequency indicates the number of times business rules change which we classify as A) low, B) medium and C) high. When the change frequency is high it is necessary to setup proper processes, roles, input and output for the audit service system and the version service system. When a business rule set never changes or almost never changes such a structure is not necessary, as described by an architect:

“We have multiple BRMSs in our organization. The business rules for insurance products change 70 times per two weeks. Here we have a very strict change process that exists of five formal steps [...] and a very strict version and audit policy. [...] We also apply business rules for specific events, checking these business rules haven't changed the last 1,5 let's say 2 years. This process does not have a strict and formal change process and versions aren't saved”

The *fifth situational factor* is 5) *N-Order compliancy*. N-Order compliancy is a measurement to measure the number of actors between the enforcer and/or creator of the law/regulation/strategy and the actual implementation by means of business rule models. Only one role within organizations has the power (and knowledge) to provide 1st order compliancy: the role that defines the regulation. They can achieve this by translating the law into a business rules model themselves or by validating the model created by other roles. To achieve this in practice specific roles and control elements need to be added to the design, verification and validation service systems. In other situations 1st order compliance is not possible at all and the design, verification and validation service systems need to be designed in a different manner as this business architect explains:

“Most of our business rules are directly derived from regulation. Regulation created by lawyers at the ministries. This regulation is interpreted by our analysts and models are created. In the old situation these models supposed to

be checked by our own lawyers however this check only existed on paper. In the current situation our analysts still transform the regulation to models. However our lawyers validate the models. It would be more convenient if our lawyers could do the translation. It would be perfect if the lawyers at the ministries and our lawyers together would do the translation.”

Another situational factor related to organizational structure is present in all cases, i.e. *Project Philosophy*. Project philosophy is the development philosophy the organizational unit follows. Values identified during our analysis are A) agile, B) waterfall and a C) combination of both. After debating this situational factor we decided to remove it from our analysis. The rationale behind this decision is that every solution implemented in an organization has a specific project philosophy which is not unique for a BRMS.

3.8 Reduction of Freedom: Physical Structure Situational Factors

Physical structure is recognized as a separate structure. Still the situational factors identified are highly coupled to the situational factors of the deep structure. This is consistent with the viewpoint expressed by Weber (1997) that the physical structure is the way in which the deep structure is mapped onto hardware and software. To support the different aspects of a BRMS multiple software functions are needed. These functions can be integrated into one software package or distributed across multiple software packages.

The *sixth situational factor* the 6) *integrative power of the software environment* is a measurement to determine the distribution of functions needed for the BRMS. Our analysis revealed two values: A) integrated and B) non-integrated. A software environment that is integrated provides software functions for one or more service systems within one software package. A software package that delivers functions to support only one service system is a non-integrated software system. A business architect describes this functionality in practice:

“In general all functions needed for a BRMS can be loosely coupled. However, performance of specific tasks will be highly effect if specific functions are loosely coupled. Examples of such tasks are predictive analytics, simulation or

high performance monitoring. In these cases software packages that integrate design, validation and improvement must be used to deliver the solution.”

3.9 Contributions, limitations and discussion

From a research perspective our study provides a theoretical fundament for the BRMS problem space and configuration of underlying service systems. An important step since clusters have been defined that can be used to define situational methods, grammars and practitioners can better manage resources within business rules service systems. The contribution of our problem space framework for BRMS can be understood in relation to design research literature, ‘organization-enterprise system fit literature’ and ‘management fit literature’. Most authors start the design process with the identification of the relevant problem (Baskerville et al. 2009, Eekels & Roozenburg, 1991; Takeda et al. 1990). However, when taking into account situational factors, current research often does not focus on identifying the problem space but rather the specific design implementation.

We consider Sia and Soh’s (2007) misalignment assessment framework, and Strong and Volkoff’s (2010) organization-enterprise system fit types. Sia and Soh’s (2007) propose a framework that predicts how organizations will resolve misfits in enterprise system configuration. The data analyzed by Sia and Soh (2007) is based on change requests for enterprise systems. Thus their framework measures misfit of the solution artifact deployed which is the information system. They apply three measurements (severity, frequency, and resolution) to externally imposed criteria and voluntarily acquired criteria (Sia & Soh, 2007). The criteria are also mapped on Wand and Weber’s ontological structure (Wand & Weber, 1995). In Sia and Soh’s (2007) framework one cannot distinguish between misfits caused by wrong assessment of the problem space and a wrong implementation of the solution artifact. Our framework allows us to do so.

Strong and Volkoff (2010) propose two fit types of ‘organization-enterprise system fit: 1) coverage fit and 2) enablement fit. Coverage fit is achieved by eliminating deficiencies and tailoring an information system through configuration and customization. Coverage fit affects the problem space as well as the solution artifact, since eliminating deficiencies happens in both. Enablement fit is a measurement solely for the solution artifact that is deployed

since it measures the actual usage of the information system deployed. Strong and Volkoff (2010) fit types should be further analyzed to investigate the difference between coverage fit on the problem space level and the implementation level. An example of a framework that proposes situational factors for a specific problem space is described by Henderson and Venkatraman (1993). The framework specifies four specific problem classes for the problem space business-it alignment. For each problem class they describe the limitation of freedom. For example, the role of top management is prioritizer when the problem class is service level alignment. This role changes to business visionary when the problem class changes from service level alignment to competitive potential alignment (Henderson & Venkatraman, 1993). They do not describe limitations for the solution artifact to implement the service level alignment in a specific organization. Our framework focuses on a different problem space but addresses fit in the same manner.

To accommodate different levels of situational factors we extend the enterprise system artifact proposed by Strong and Volkoff (2010) with an addition level, see Figure 3.3. Our representation presents a view of a design artifact as the combination of four structures (physical, organizational, deep, and surface) on both the design problem level as well as the solution artifact level.

However each organization experiences further limitation of freedom through situational factors. These situational factors are depicted at the lower level, the solution artifact. Apart from the contribution to the business rules management knowledge base this also illustrates a different lens when applying contingency and relational theory. Both theories are mainly adopted to analyze and illustrate the representation of design solutions, thereby ignoring situationality of the problem space. We argue that more attention should be aimed towards properly identifying, analyzing, and describing information system problem spaces.

From a practical perspective our study provides organizations and management within organizations with a diagnostic tool for identifying and describing their business rules management problem space. It offers a framework that can structure thinking about the solution to be implemented.

Several limitations may affect our results. The first limitation is the number and type of BRMSs analyzed. While we believe our study is representative of a large number of BRMSs, most solutions analyzed are implemented in organizations

based in the Netherlands. This limits generalization. The second limitation is that a number of cases were provided by two consultancy firms. It could be argued that our study reflects a bias towards the situationality the firms perceive when designing and implementing a BRMS. However, because our objective is to analyze the degree of freedom of the BRMS problem space and the consultancy firms have to deal with the situationality experienced by their customers, this does not significantly influence the results.

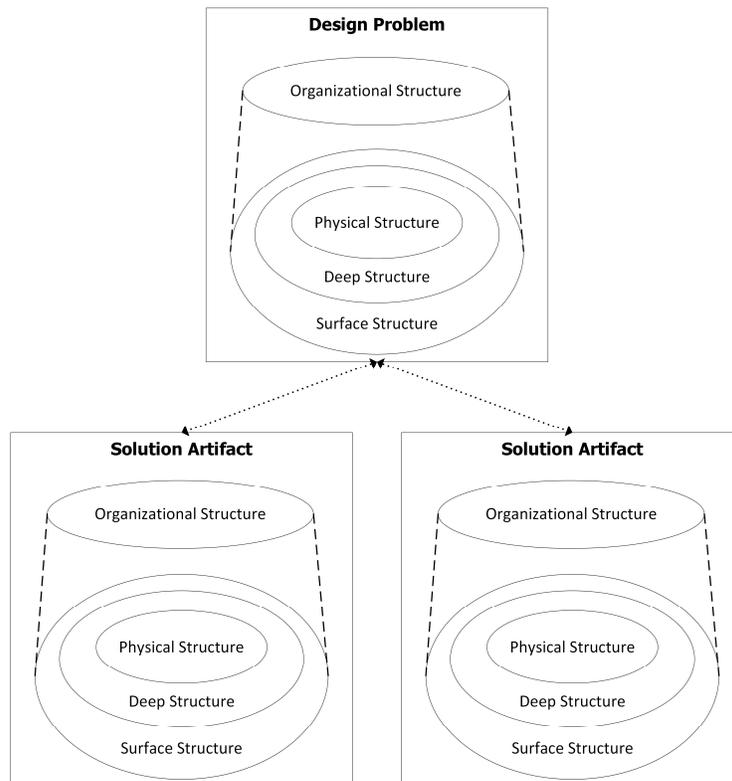


Figure 3.3: Overview Adapted Ontological Foundations of Information Systems

Our study describes a BRMS problem space relying on induction and deduction. The only way to assess the generality of a theory is through the use of deduction (Lee & Baskerville, 2003). Although deductive reasoning has been applied during this study it is only used within the analyzed cases. To further generalize the model a deductive validation outside the current units of analysis

should be conducted; we note that such a deductive validation is outside the scope of this paper.

3.10 Conclusions

This research investigated the design factors of BRMSs with the purpose of developing a conceptualization of the BRMS problem space, and from this to identify specific BRMS problem spaces. To accomplish this goal, we conducted an analysis of situational factors using ordinal analysis to assess the minimal number of situational factors necessary to classify the BRMS problem space. This analysis revealed six situational factors, see Figure 3.2: 1) value proposition, 2) approach, 3) standardization, 4) change frequency, 5) n-order compliance, and 6) integrative power of the software environment. Subsequently, analysis of the six situational factors using narrative comparison revealed three separate casual structures of situational factors 1) organizational structure, 2) deep structure and, 3) physical structure. Additionally our analysis also revealed a new conceptualization of the ontological foundations of information systems. In summary, our purpose in this paper was to study the minimal number of situational factors necessary to classify a BRMS problem class. Through coding, ordinal analysis and narrative analysis we have accomplished this purpose.

4 DEFINING COLLABORATIVE BUSINESS RULES MANAGEMENT SOLUTIONS: FRAMEWORK AND METHOD

The goal of this research is to define a method for configuring a collaborative business rules management solution from a value proposition perspective. In an earlier published study (Zoet and Versendaal, 2013) we took a business rules perspective on interorganisational collaboration optimization, when we addressed the question what the relation was between types of business interoperability and an organization's business rules management solution. Different types of collaboration were defined and subsequently combined with eleven identified types of service systems; these service systems together make up the business rules management solution. In this paper we re-address and -present our earlier work, yet based on the findings, we extend it with the construction of a method for determining the configuration of collaborative business rules management solutions. This method is tested by applying it to a case study at an alliance of airlines. Presented results provide a grounded basis from which empirical and practical research on business rules management solutions can be further explored.

4.1 Introduction

Interoperability research that considers collaboration between organizations from a business rules perspective is limited. In Zoet & Versendaal (2013) we added to business interoperability research by explicitly focusing on business rules. In particular, focusing on identifying collaborative business rules management solutions. A collaborative business rules management solution is a solution in which two or more organizations are responsible for configuration and execution of the eleven service systems that make up a business rules management solution. For example, four hospitals together *develop*, *verify* and *validate* a set of business rules. The corresponding service systems *design*, *verification*, and *validation* have to be configured to allow the hospitals to work

This work has been accepted for publication as: : Zoet, M., & Versendaal, J. Defining Collaborative Business Rules Management Solutions: Framework and Method. Information Systems and E-Business Management.

An earlier version was published as: Zoet, M., & Versendaal, J. (2013B). Business Rules Management Service System: Added Value by Means of Business Interoperability. In v. M. Sinderen, P. Oude Luttighuis, E. Folmer & S. Bosms (Eds.), *International IFIP Working Conference on Enterprise Interoperability* (Vol. 144, pp. 145-157). Twente: Springer.

with each other; additional protocols or technical solutions might be required. For example, individual hospitals cannot submit test data for validation without removing privacy sensitive data.

The logical reason for individual organizations to participate in a collaborative business rules management solution is the added value it provides in terms of effectiveness, efficiency, and/or compliancy. From the Zoet and Versendaal (2013) study the literature part (discussing added value), workshop results and findings from the projects are re-presented as well as the resulting definition of the relations between collaboration types and service system configuration. We extend our earlier study with a method for business rules management solution configuration, which is subsequently tested in a case study.

Many business services nowadays heavily rely on business rules to express business entities, coordination, constraints and decisions (Shao and Pound 1999; Bajec and Krisper 2005; Zoet et al. 2009; Burstein and Holsapple 2008). A business rule is (Morgan 2002) "a statement that defines or constrains some aspect of the business intending to assert business structure or to control the behavior of the business." The field of business rules management knows various research streams. Examples are business rules authoring, business rules engines, application in expert systems, business rules architecture, business rules ontologies, data mining and artificial intelligence (Zoet et al. 2009; Russell et al. 2010). However, the research topics within each stream are technology driven (Arnott and Pervan 2005; Rosca and Wild 2002). Yet, it is not the technology and software applications that are of interest to an organization; it is the value proposition they deliver. Nevertheless research focusing on improving business rules management practices and its value proposition is nascent (Nelson et al. 2010; Arnott and Pervan 2005).

An important design factor to increase an organization's value proposition in general is cooperation, see for example (Hammer and Champy 2003). To achieve effective cooperation organizations have to resolve interoperability issues. In this study business interoperability is defined as (Lankhorst et al. 2012) "the organizational and operational ability of an enterprise to cooperate with its business partners and to efficiently establish, conduct and develop IT-supported business relationships with the objective to create value." However, current interoperability research primarily focuses on data, services, processes, business and interaction and not explicitly on business rules (Molina et al. 2007). For each previously mentioned concept three categories of interoperability

research can be distinguished: conceptual, technological and organizational (Chen et al. 2008). Conceptual research focuses on barriers related to syntax and semantics, technological research focuses on information system technology while organizational research focuses on responsibility, organizational structure and business value. All research streams have the same purpose: to develop knowledge and solutions to remove barriers and enable effective business interoperability (Chen et al. 2008). Since interoperability research related to business rules is nascent research needs to focus on the inquiry of the phenomenon itself (Edmondson and McManus 2007).

This paper extends understanding of business interoperability by addressing the underlying value proposition for organizations from a business rules perspective. Business rules management is the vehicle to address this perspective. Based on previous research, we will consider a Business Rules Management Solution (hence BRMS) as consisting of eleven different service systems. With these premises, the research question addressed is:

“How to configure a Business Rules Management Solution for collaboration optimization?”

Answering this question will help organizations applying a business rules management perspective for determining a strategy on collaboration and executing on this. To provide an answer to this research question we develop a method for determining a configuration for an interorganisational BRMS. A method is an approach to determine, in our case, a configuration (Brinkkemper 1996) “based on a specific way of thinking, consisting of directions and rules, structured in a systematic way in [...] activities with corresponding [...] products.”

The paper is organized as follows. First we describe the individual service systems of a BRMS. Then we present the various forms of interoperability and stages of service design. After which we present our data collection and analysis, followed by the method for business interoperability configuration in terms of a BRMS. We conclude with a discussion of these findings, focusing on the implications for practice and for the study of business rules based services.

4.2 Literature

Business rules classification

A business rule is (Morgan 2002): *"a statement that defines or constrains some aspect of the business intending to assert business structure or to control the behavior of the business."* In literature multiple business rules classifications exist. Classifications are based on domains (Ross 1997; Kardasis and Loucopoulos 2004), implementation techniques (Vassiliadis et al. 2000; Coltrera 2002), specification technique (Hay and Healy 2000; Park and Injun 2004), and intended behavior (Gottesdiener and Consulting 1997; Shao and Pound 1999). The first two classifications can be considered additional attributes to a specific business rule. The domain indicates the department or business function the business rule is implemented. For example, marketing business rules or sales business rules. The classifications based on technique indicates the actual system the business rule is implemented in. For example, in a database, in source code or in a business rules engine. The third classification type positions business rules in relation with policies. The challenge for business rules implementation from policies is the ambiguity and possible interpretation of a statement. Policies and laws are open for interpretation while rule statements can be interpreted in one way and one way only (Hay and Healy 2000; Park and Injun 2004). The difference between intended business rules and implemented business rules is that the first is formulated independent of a specific piece of software while the second is the implementation of a business rule in that specific software.

A commonly applied classification is the distinction between structural and operational business rules. Structural (definitional) business rules guide/constrain the vocabulary used in an organization. They are applied to give meaning to facts, terms and concepts such as client, order and department. Operational (behavioral) business rules guide/constrain an action in a specific situation. For example, the statement *"a frequent flyer must be allowed access to the airline lounge."* For business rules to deliver any value business services need to be in place.

Service systems

A business service is defined as (Lankhorst et al. 2012): *"a coherent piece of functionality that offers added value to the environment, independent of the way this functionality is realized."* To deliver a business service a value-coproduction of resources, skills, knowledge and competences has to be

configured (Lankhorst et al. 2012). This configuration is called a service system. A BRMS is a co-production of various resources, skills, knowledge and competences (Nelson et al. 2010; Nelson et al. 2008; Zoet and Versendaal 2012): i.e. a co-production of service systems. Nelson (Nelson et al. 2010) proposed a very rudimentary service system for business rules containing three elements: a) a service provider, b) a service client and c) a service target. A more detailed classification has been proposed by Zoet and Versendaal (Zoet and Versendaal 2012). This classification scheme, existing of eleven service systems, classifies the processes, guidance elements, actors, and input and output per service system. A detailed explanation of the BRMS can be found in (Zoet and Versendaal 2012). However, to ground our research and method, a summary is provided.

Deployed business rules are monitored for proper execution. The 1) *monitoring service system* collects information from executed business rules and generates alerts when specific events occur. This information in turn can be used to improve existing business rules models or design new ones. Execution of business rules is guided by a separate service system: the 2) *execution service system*. It transforms a platform specific rule model into the value proposition it must deliver. A platform specific business rules model can be: a) source code, b) handbooks or c) procedures. The execution in turn can be automated or performed by humans. To execute a platform specific business rules model it needs to be created. A platform specific business rules model is created from a non-platform specific business rules model by the 3) *deployment service system*. Before deploying business rules models they have to be checked for two types of errors: a) semantic/syntactical errors and b) errors in its intended behavior. The first type of errors are removed from the business model by the 4) *verification service system*; the latter by the 5) *validation service system*. The business rules model itself is created within the 6) *design service system*. In addition a 7) *improvement service system* exists. The improvement service system includes functionality for impact analysis execution. To design business rules models data sources need to be mined; the 8) *mining service system* contains processes, techniques and tools to extract information from various data sources, by human or automated. Before mining can commence in some cases explicit data sources need to be cleansed. The 9) *cleansing service system* removes all additional information intervening with proper mining or design activities. Each previously mentioned service system provides output to two management service systems: the 10) *version service system* and the 11) *audit service system*. Changes made to the data source, platform specific

business rules models, non-platform specific business rules models and all other input and output are registered by the version service. All data collected on realizing changes to specific input, output and other service system elements are registered by the audit service system. Examples of registered elements are: execution dates, business rules model usage, business rules model editing, verification and validation. All described service systems need to be designed, developed and executed. Service design is the process of requirements analysis and service discovery. After requirements are analyzed the service system needs to be configured. For this interaction, roles, functions, processes, knowledge and products need to be defined. After the service system is configured the service itself needs to be executed.

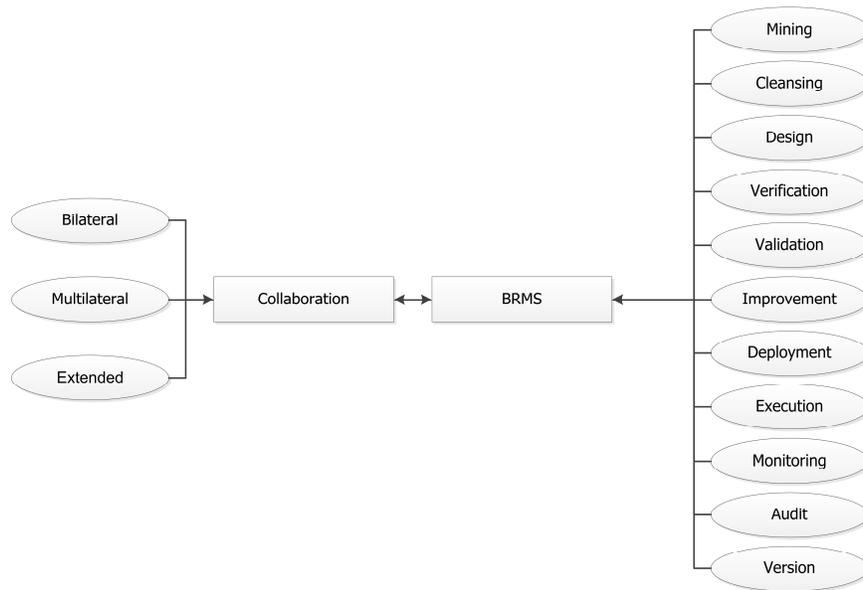


Figure 4.1: Schematic Overview researched relations between discussed concepts

Collaboration levels and classification

From literature four levels of collaboration can be recognized: 1) no collaboration, 2) bilateral collaboration, 3) multilateral collaboration and 4) extended collaboration, see for example (Plomp and Batenburg 2010). Two organizations within the same industry or value chain working together perform bilateral collaboration. Multilateral collaborations have the same characteristics as bilateral collaborations with the difference that more than two parties are involved. Extended collaboration describes many-to-many and 'n-tier'

relationships between organizations. Examples are consultative bodies and network orchestrators. We assume that the type of collaboration implies different design, development and execution of the BRMS. Figure 4.1 schematically illustrates these dependencies.

Nelson et al. (2010) classify interdepartmental collaboration for a specific BRMS along five dimensions: scope, ownership, development responsibility, implementation responsibility, and structure. We adopt these dimensions but also adjust them in order to fit interorganisational collaboration. Nelson et al. (2010) specify three values for the variable *scope*: project based, departmental and organizational. Since focus of this research is on BRMS that extends a single organizational entity the values are adjusted accordingly. We propose the following values: none, bilateral, multilateral and extended. *Ownership* deals with the organization that owns an aspect of business rules based collaboration and in our model is divided into two dimensions: ownership of the input and ownership of the output of a service system. *Development responsibility* is defined as the organization that executes the service system development process and *implementation responsibility* is defined as the organization that implements the service system. For *structure* no predefined variables are set, while purpose of this research is to discover if such structures exists.

Value proposition

A qualitative or quantitative benefit that organizations or individuals experience can be defined as *value*. *Added value* can be defined as the difference between 1) the value organizations create on their own and 2) additional value that can be created when cooperating with other organizations. In this research we focus on value proposition that can be achieved by business rules in an interorganisational context. Added value of collaboration between organizations has been extensively researched and described. Examples of added value identified in previous research are improvements in throughput, cycle time reduction and reduction of transaction costs (e.g. Legner and Lebreton 2007). Although we recognize the potential advantages in terms of economic value and economy of scale, this research focuses on potential added value in terms of (platform-independent/platform-dependent) business rules model quality in an interorganisational context.

To the knowledge of the authors, no standardized set of quality measurements for business rules models exists. However, a standardized set does exist for software product quality: ISO/IEC 25010:2011. ISO 25010 prescribes eight

product quality characteristics to measure static and dynamic properties. Static properties measure the quality of source code while dynamic properties measure the performance of executed software. Business rules models describe behavior; therefore we adopt the *static* measurements from ISO 25010: 1) functional suitability and 2) maintainability. The degree to which a business rules model delivers value is defined as functional suitability. Functional suitability can be decomposed in two lower-level criteria: *correctness* and *reliability*. Maintainability is defined as the effort required for testing a business rules model or locating and fixing an error in an operational business rules model. Only one measurement is adopted from the *dynamic* properties of software product quality: 3) performance efficiency. Performance efficiency is defined as the amount of resources used to execute the business rules model and the amount of resources used to deliver its value proposition. Remaining five software quality characteristics specifically measure underlying hardware configurations and/or user interaction. The main reason we do not take into account hardware configuration and user interaction measurements is because both measurements focus on the actual instantiations of an implementation.

4.3 Data collection

The goal of this research is to define a method for configuring a collaborative BRMS from a value proposition perspective. To reach this goal we first collected data to determine the added value of interoperability on individual BRM service systems. Data was collected in two ways: through a focus group workshop and through a survey. Based on the result an interoperability method has been created which was subsequently evaluated during the second phase: evaluation took place by means of a case study at FlyAwayAirlines.

Focus Group Data Collection. During the first phase, a focus group was held in order to determine the added value of interoperability on individual BRM service systems. The purpose of the focus group was to develop an understanding of the added value business interoperability offers to BRMS and the challenges encountered. A focus group is a group of individuals selected to discuss and comment on topics supplied by the researcher (Powell et al., 1996; Kid, 2000). In total six individuals were selected to participate in the focus group. Four of the focus group members are business rules analysts and two members are business rules architects. The session lasted four hours and was divided into three blocks. During the first block multiple BRMSs were shown to

the group and for each service system two questions were posed: what is the potential added value of interoperability and how are ownership input, ownership output, development responsibility and implementation responsibility of the service affected when interoperability is realized? During the second block each individual respondent could pose additional values, which were not addressed during the first block. During the third block all added values and corresponding characteristics were grouped and summarized.

Survey Data Collection. Like the focus group workshop the survey was applied to identify the potential added value of interoperability. Our selection for surveying projects was based on theoretical and pragmatic criteria. The first theoretical criterion was: "written documentation explaining the added value of the BRMS must exist." The second theoretical criterion was: "written documentation explaining the implementation of the BRMS must exist." The only pragmatic criterion was: "site/document access." Based on these criteria twelve projects were chosen to conduct the survey at. Five projects were executed by governmental institutions, two projects in the financial industry, three projects in the medical industry, one project in the housing industry and one in the fashion industry.

Case Study Data Collection. Phase two was performed for evaluating purposes on the results as identified in the first phase. To collect the data a case study (Yin, 2004) was executed. Our choice for a case site was based on theoretical and pragmatic criteria. The first theoretical criterion was: "the organization must have implemented collaborative BRMS." The second theoretical criterion was: "the collaborative BRMS must have undergone changes over time." The only pragmatic criterion was: "site access." Based on these criteria FlyAwayAirlines, an airline, had been chosen to conduct the case study at. FlyAwayAirlines (FAA) is an airline serving over 100 destinations. FAA is part of the global airline alliance Fly the World (FTW). FTW has over 10 partners that together provide over 10.000 flights daily. The airlines within the alliance share multiple business rules models with each other therefore providing a proper case study environment. Data was collected through A) written documentation existing of vision documents, project documentation, internal communication, project presentations and evaluations and B) semi-structured interviews with two respondents, an enterprise architect and a business analyst. Interviews took about two and half hours and were recorded.

4.4 Focus group and survey analysis

Analysis of the focus group workshop and survey data followed two cycles of coding: 1) added value coding and 2) characteristics coding. During both cycles the unit of analysis were sentences and individual words (Boyatzis, 1998). For an example of coding see Table 4-1. The column "Text" contains the actual text that is coded. If an element described in the text benefits from interoperability it is coded as "Adds value". The last column "Explanation" describes which added value is realized by interoperability. For example, added value of interoperability is that multiple specialists from different hospitals can validate the business rules that increase overall validity of the business rules.

Table 4-1: Example Coding

Text	Adds Value	Explanation
The draft rule set is based on clinical practice guidelines and practitioners' experiences. Draft rule sets are validated by specialists and case data. Most important elements during the development of a rule set is to ensure safe and relevant alerts and instructions.	Clinical Practice Guidelines	Increased Validity
	Practitioners' Experiences	Increased Validity
	Specialists	Increased Validity
	Case Data	Increased Validity

During the second cycle of coding the input, ownership, output, development responsibility, and implementation responsibility per added value have been evaluated. For example, who is the owner of the case data provided or who is responsible for validating the rule set? Next, all added values and corresponding characteristics have been grouped and summarized.

Section 4.1 to 4.5 describes in more detail the results and analysis of phase one. Each section contains a textual description and an interoperability characteristics table, see Table 4-2. The left column of the table presents the five characteristics evaluated. The remaining three columns each show a specific type of collaboration: bilateral, multilateral and extended. Per collaboration type the organization that owns the input and output is depicted; also the responsible organization for development is depicted. This can be the receiving organization, the providing organization, the consortium or a combination. In addition to the organization some tables contain an additional variable. This additional variable indicates whether the ownership or

responsibility depends on a third variable, for example *privacy*. In these specific cases the characteristic is split into two rows containing the ownership and responsibility of both instantiations of the variable.

Table 4-2: Interoperability Characteristics Template

	Bilateral	Multilateral	Extended
Ownership Input	Providing Org.		
Ownership Output	Providing Org. / Receiving Org.		
Development Responsibility	Privacy: Receiving Org.		
	None Privacy: Receiving or Providing Org.		
Implementation Responsibility	Receiving Org.		

4.4.1 *Cleansing service system and mining service system interoperability*

Explicit and tacit data sources are input for the business rules mining service system, cleansing service system, and design service system. Cleansing and mining are discussed in this section; the design service system in the next. The business interoperability question with regard to data sources is: can data from multiple organizations add additional value compared to data from a single organization? Multiple organizations create and execute very similar or identical business rules models. Examples of such business rules models are medical treatment rules within the healthcare industry (Ferlie et al. 2012) and fraud detection rules used by banks and insurers (Chiu and Tsai 2004). Improvement of such business rules sets is based on execution of data in a single organization. By means of collaboration larger and more accurate data sources can be created. Overall characteristics of the interoperability design issues for the mining and cleansing service system are depicted in Table 4-3 and

Table 4-4. Both tables show an additional variable influencing the development responsibility: privacy.

Privacy influences the question which organization is responsible for cleansing. If the data source contains sensitive information cleansing should occur at the providing organization in the case of bilateral or multilateral collaboration. Cleansing in this case can also mean sanitizing or anonymizing data (Chiu and Tsai 2004). Extended collaboration implies the same question. However, when data is collected and integrated by an independent consultative body this question may be easier to solve from a political viewpoint (Monsieur et al. 2008). After the data source is created it can be used to mine business rules. When an extended collaboration is realized the consultative body can mine the data sources after which the proposed business rules are shared with all partners in e.g. the healthcare industry (Ferlie et al. 2012). Other forms of collaboration have two choices: 1) each party mines the data source itself or 2) they appoint a partner to do so thus in fact creating an extended collaboration.

Table 4-3: Interoperability Characteristics Mining Service System

	Bilateral	Multilateral	Extended
Ownership Input	Providing Org.	Providing Org.	Providing Org.
Ownership Output	Providing Org. / / Receiving Org.	Providing Org. / Receiving Org.	Consortium
Development Responsibility	Privacy: Receiving Org.	Privacy: Receiving Org.	Privacy: Receiving Org.
	None Privacy: Receiving or Providing Org.	None Privacy: Receiving or Providing Org.	None Privacy: Receiving or Providing Org.
Implementation Responsibility	Receiving Org.	Receiving Org.	Receiving Org.

Table 4-4: Interoperability Characteristics Cleansing Service System

	Bilateral	Multilateral	Extended
Ownership Input	Providing Org.	Providing Org.	Providing Org.
Ownership Output	Providing Org. / Receiving Org.	Providing Org. / Receiving Org.	Consortium
Development Responsibility	Privacy: Receiving Org.	Privacy: Receiving Org.	Privacy: Receiving Org.
	None Privacy: Receiving or Providing Org.	None Privacy: Receiving or Providing Org.	None Privacy: Receiving or Providing Org.
Implementation Responsibility	Receiving Org.	Receiving Org.	Receiving Org.

4.4.2 Design service system interoperability

The design of a business rules model is based on a specific data source or on proposed business rules. An additional variable has been identified influencing the design service system: 'partner type'. A partner can be either a rule-chain partner or a competitive (none rule-chain) partner, see second column Table 4-5. Competitive partners are defined as organizational entities from the same industry realizing an identical value proposition. A rule-chain partner is an organizational entity that either formulates data sources or business rules that must be implemented by the organization or an organizational entity that should implement business rules or data sources defined by the organization.

Interoperability between rule-chain partners adds an extra dimension to designing a business rules model. An example from the public sector demonstrates this. The ministry of finance formulates tax laws that are analyzed by the tax and customs administration to formulate business rules models. These business rules models are deployed into software and into forms, which are then sent to citizens. In addition to the tax and customs administration multiple commercial and non-commercial organizations also formulate business rules based on the same tax laws. The same applies to other laws like for example the Sarbanes-Oxley Act (SOX) or the Fair and Accurate Credit Transaction Act (FACTA). All commercial organizations governed by specific laws are building business rules models based on the text provided by the United States Government. Who should translate the tax laws to business rules models? SOX and FACTA? The government or the individual

commercial and non-commercial organizations governed by the business rules? To answer these questions first the difference between *internal* business rules and *external* business rules has to be explained.

Table 4-5: Interoperability Characteristics Design Service System

	Bilateral	Multilateral	Extended
Ownership Input	Rule-Chain: 1 st order party	Rule-Chain: 1 st order party	Rule-Chain: 1 st order party
	None Rule-Chain: Providing Org.	None Rule-Chain: Providing Org.	None Rule-Chain: Consortium
Ownership Output	Rule-Chain: 1 st order party	Rule-Chain: 1 st order party	Rule-Chain: 1 st order party
	None Rule-Chain: Providing Org. / Receiving Org.	None Rule-Chain: Individual Org./ Receiving Org.	None Rule-Chain: Consortium
Development Responsibility	Rule-Chain: 1 st order party	Rule-Chain: 1 st order party	Rule-Chain: 1 st order party
	None Rule-Chain: Receiving Org.	None Rule-Chain: Receiving Org.	None Rule-Chain: Consortium
Implementation Responsibility	Rule-Chain: Receiving Org.	Rule-Chain: Receiving Org.	Rule-Chain: Receiving Org.
	None Rule-Chain: Receiving Org.	None Rule-Chain: Receiving Org.	None Rule-Chain: Receiving Org.

Two main sources of business rules can be distinguished, namely *internal* business rules sources and *external* business rules sources (Zoet et al. 2009). This adheres to the principle within risk management where a distinction exists between operational risk and compliance (Zoet et al. 2011). External business rules are specified by external parties through the creation of regulations stating which business rules an organization needs to comply to. Internal business rules sources are specified by the organization itself; they decide which rules they want to enforce. With external business rules organizations

have to prove, based on externally imposed criteria, that they have established a sufficient system to control business rules. For internal business rules there are no externally applied criteria or needs to prove sufficient control; in this case organizations can implement their own criteria and create a system for measuring this. Expanding on the difference in enforceability indicates a mismatch in the power/knowledge nexus (Foucault 2007). In practice organization will translate laws and regulations to business rules in one of two ways: either they transform laws and regulations themselves or they will hire a vendor, system integrator or consultancy firm to translate laws and regulations for them. In all cases the organization that performs the translation is not the organization that enforces the regulation. The number of parties between the enforcer and/or creator of the law and the actual implementation by means of business rule models is defined as *n-order compliancy*, see Figure 4.2, and its processing in Table 4-5. If government agency X states law Z and organization Y hires a consultancy firm to translate and implement the law by means of business rules they are 3rd order compliant. If they translate and implement the law directly they are 2nd order compliant. Only one organization has the power (or knowledge) to provide 1st order compliancy, the organization that defines the regulation, government agency X. They can achieve this by translating the law into a business rule model and distribute this model to the organizations. The same situation can be recognized within individual organizations. One department specifies strategy and internal policies. A second department translates the strategy to operational business rules. In turn the operational business rules are distributed to the information technology department achieving 2nd or 3rd order compliancy.

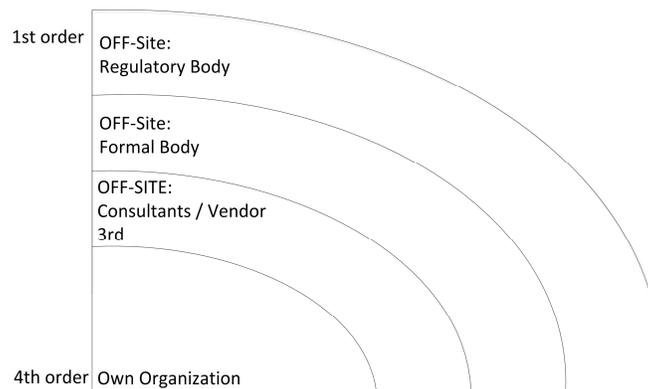


Figure 4.2: Schematic Overview N-Order Compliancy

With respect to organizational collaboration in a rule-chain the preferable solution would be that 1st order compliancy is achieved. Thus that the regulatory body who defines the legislation also creates and distributes the business rules model. However, currently only one example of this is known to the authors, i.c. the Australian Taxation Office (Office 2012). In all other cases it is recommended to keep the n in n-order compliancy as low as possible.

4.4.3 Validation service system interoperability

Validation is the service system that explores errors in the intended behavior of business rules models by means of test cases containing real life data. Likewise to the design service system the partner type also influences validation, see Table 4-6.

Table 4-6: Interoperability Characteristics Validation Service System

	Bilateral	Multilateral	Extended
Ownership Input	Providing Org.	Providing Org.	Providing Org.
Ownership Output	Providing Org.	Providing Org.	Providing Org.
Development Responsibility	Rule-Chain: 1 st order party	Rule-Chain: 1 st order party	Rule-Chain: 1 st order party
	None Rule-Chain: Receiving Org.	None Rule-Chain: Receiving Org.	None Rule-Chain: Consortium
Implementation Responsibility	Rule-Chain: Providing Org.	Rule-Chain: Providing Org.	Rule-Chain: Providing Org.
	None Rule-Chain: Providing Org.	None Rule-Chain: Providing Org.	None Rule-Chain: Providing Org.

First order compliancy can still be achieved within the validation service system when the enforceable party is not responsible for the business rules model design however they need to validate the designed model and declare it 'compliant'. The respondents and authors have no knowledge about a public body officially validating external business rules models. Examples can be found in commercial rule-chains. Authorized insurance brokers review, accept, administer, collect premiums and execute claim settlement for insurance agencies. They define business rules models to support the previous mentioned tasks. Before deploying the actual business rules models insurance organizations apply their test set to test if business rules are properly deployed. If so, they consent on deploying the service to the live environment. In these

cases an extended collaboration is established with the authorized insurance broker as consultative body. Other examples can be found in the healthcare industry where various consultative bodies have test cases for rule sets for diagnoses. Bilateral or multilateral collaborations between two organizations can also apply validation in the same manner. Another possibility is sharing test cases between collaboration partners instead of 'outsourcing' the validation process.

4.4.4 Deployment, execution and monitoring service system interoperability

Within three investigated projects information system deployment and maintenance are outsourced to a third party, e.g. a system integrator. None-platform specific business rules models were transformed to platform-specific business rules models by the third party. The implementation and development responsibility in all collaboration forms lies with the receiving organization (i.e. the system integrator). Ownership of the input and output in most cases lies by the providing organization, see Table 4-7.

Table 4-7: Interoperability Characteristics Deployment Service System

	Bilateral	Multilateral	Extended
Ownership Input	Providing Org.	Providing Org.	Providing Org.
Ownership Output	Providing Org.	Providing Org.	Consortium
Development Responsibility	Receiving Org.	Receiving Org.	Receiving Org.
Implementation Responsibility	Receiving Org.	Receiving Org.	Receiving Org.

Execution interoperability occurs when one or more organization(s) offer(s) a value proposition realized by means of a platform specific business rules model to one or more organization(s). The airline alliance example described earlier is an example of this type of collaboration, which can be classified as business rules as a service. Another example can be found in the healthcare sector where specific a hospital offers a decisions service to multiple of its peers. No additional variables impacting the characteristics have been found, see Table 4-8.

Monitoring service system collaboration mainly occurs in rule-chains since most organizations will not provide monitoring services to competitors. A possible exception might be in extended collaboration with a consultative body. An

instantiation of a rule-chain within the insurance industry is when an inspector applies a business rules model to determine if a vehicle is either repairable or total loss. Based on the results of the execution of the business rules model the insurance companies start different process flows. Although not a collaboration between two organizations, another pattern instantiation is identified in the business-to-consumer industry: telemedical care for patients (Fifer et al. 2010). The patient has physical equipment at home that contains the specific business rules model. The execution of this model is monitored at the hospital or medical centre. All types of collaboration have the same dimension characteristics, see Table 4-9.

Table 4-8: Interoperability Characteristics Execution Service System

	Bilateral	Multilateral	Extended
Ownership Input	Providing Org.	Providing Org.	Providing Org.
Ownership Output	Receiving Org.	Receiving Org.	Receiving Org.
Development Responsibility	Providing Org.	Providing Org.	Providing Org.
Implementation Responsibility	Receiving Org.	Receiving Org.	Receiving Org.

Table 4-9: Interoperability Characteristics Monitoring Service System

	Bilateral	Multilateral	Extended
Ownership Input	Providing Org.	Providing Org.	Providing Org.
Ownership Output	Providing Org./ Receiving Org.	Providing Org./ Receiving Org.	Consortium
Development Responsibility	Providing Org./ Receiving Org.	Providing Org./ Receiving Org.	Providing Org./ Receiving Org.
Implementation Responsibility	Providing Org./ Receiving Org.	Providing Org./ Receiving Org.	Providing Org./ Receiving Org.

Regarding the audit service system and version service system no advantages can be distinguished regarding bilateral and multilateral collaborations. In extended collaboration consultative bodies and individual organizations need to determine how to manage local and network versions of the various business rules concepts. However, one can argue this can be considered overhead instead of added value.

4.4.5 Method engineering

Analysis of the added value and the characteristics ownership input, ownership output, development responsibilities and implementation responsibilities revealed multiple configurations for the service systems, and two situational factors: privacy and partner type. The configuration of a specific BRMS depends on the added value the organization or organizations want to realize. In the remainder of this section first a standard collaborative BRMS is discussed after which the two situational factors are elaborated on.

Standard collaborative BRMS. The standard collaborative BRMS profile is aimed at improving the *correctness* and *reliability* of an internal BRMS value proposition, for example the improvement of fraud detection. Each service system is developed and implemented locally. To improve the correctness and reliability of fraud detection, and underlying business rules model, collaboration partners provide input for the mining service system, design service system, and validation service system.

Situational factor A: privacy. If input data for the mining service system, design service system or validation service system contains elements that are protected by privacy regulation the deployment responsibility for the mining and cleansing service systems rests with the providing organization. For example, when fraud detection rules are applied to customer data the customer profile and data must be cleansed before sent to collaborating organizations.

Situational factor B: partner type. When an organization has to implement a business rules model based on externally defined specifications a rule-chain exists. Implicitly incorporated in a rule-chain is the power/knowledge nexus. Only the first-order party has the knowledge and power to design and validate the business rules model. This implies that, when possible, the first-order party should deploy and implement the design service system, verification service system, validation service system and deployment service system. The organization that executes the business rules model should provide the first-order party with execution data which can be used to improve the business rules model.

Based on previous findings we engineer a method that determines the most suitable configuration for a BRMS. The discipline to design, construct and adapt methods, techniques and tools for the development of information systems is

defined method engineering (Brinkkemper 1996). In this research we focus on the method and its tuning to the situation at hand (i.e. we consider an interorganisational setting) and not on the technique and tool. Stated differently, our focus is on activities with corresponding products and not on procedures and notation to perform an activity nor on means to support the procedures and notations. The development rationale for this is that multiple techniques can be applied to identify privacy restrictions or other elements for example, interviews or brainstorming. To determine the most suitable interorganisational configuration we need to take into account previously mentioned elements: 1) the type of collaboration, 2) the two situational factors, and 3) the quality criteria. This raises the question if each element independently affects a BRMS configuration or if dependencies exist. To analyze potential dependencies we apply process families and mean-goals families to identify stages, temporal ordering, phases and chains (Glaser 1978).

The quality criteria and situational factor partner type have a dependency. The partner type influences the realization of specific quality criteria. For example, performance efficiency in a rule-chain can be realized by separating the development responsibility and implementation responsibility of the execution service system. In a competitive environment this responsibility cannot be separated because a competitor would directly affect the execution of the service the firm provides. Therefore to determine the effect of chosen quality criteria first the partner type needs to be determined. Determination of the privacy configuration has no functional dependency with the type of collaboration, the partner type or the collaboration goals. Therefore this activity and related changes to the BRMS can be executed at any specific moment in the method. However, the influence of privacy regulation does affect the efficiency of the BRMS configuration. For example, if data can be sent from organization A to organization B without cleansing it is more effective. For this reason we have chosen to position the effect of the privacy configuration after the collaboration goals, since the result of the collaboration goals would be the more effective if privacy regulation were not in place. Summarizing, this results in the method as shown in Figure 4.3.

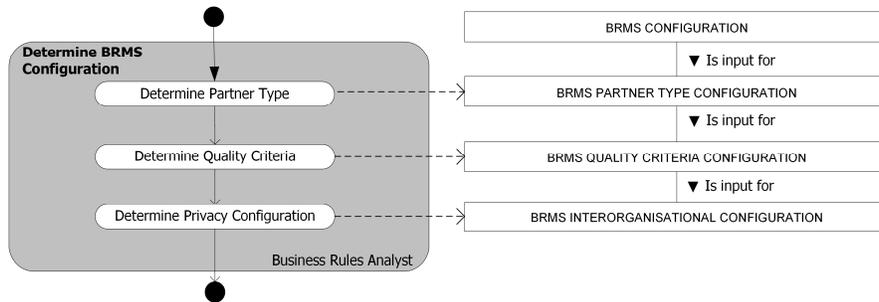


Figure 4.3: BRMS Collaboration Determination Method

To demonstrate the application of the method we provide an illustrative example. The starting point of the method is a BRMS configuration in which each service system is executed within a single organization, see Figure 4.4 left table. The first step is to determine the partner type the organization is a part of: a rule-chain or none rule-chain. If the organization is part of rule-chain they need to determine if they receive policies that need to be implemented or if they are the supplier of policies that need to be implemented. Figure 4.4 illustrates an example where the organization is part of a rule-chain and receives policies that need to be implemented. The most efficient solution is to be only responsible for the execution of the execution service system. However in the example the organization chooses to perform the monitoring and auditing internally, see Figure 4.4 middle table. After the BRMS has been established the quality criteria need to be determined.

In total four quality criteria are defined 1) correctness, 2) reliability, 3) maintainability, and 4) performance efficiency. Each criterion can influence the configuration of one or more service systems. For example, to improve correctness and reliability of the business rules model in a non rule-chain BRMS input data for the validation service system can be collected from customers or partners. To improve the correctness and reliability for a rule-chain BRMS the entire mining, cleansing, design, verification and validation service system can be outsourced to the policy partner as it will result in higher level compliance. For an explanation on how individual quality criteria affect the various service system we refer to section 4. During the third step the privacy of the data is assessed. If privacy regulated data is exchanged the configuration of the mining, cleansing and monitoring service systems are adjusted. Each of the development responsibilities is set to the organization that provides the data,

see figure 4 right table. If non-regulated data is exchanged organizations can mutually decide who develops the service system.

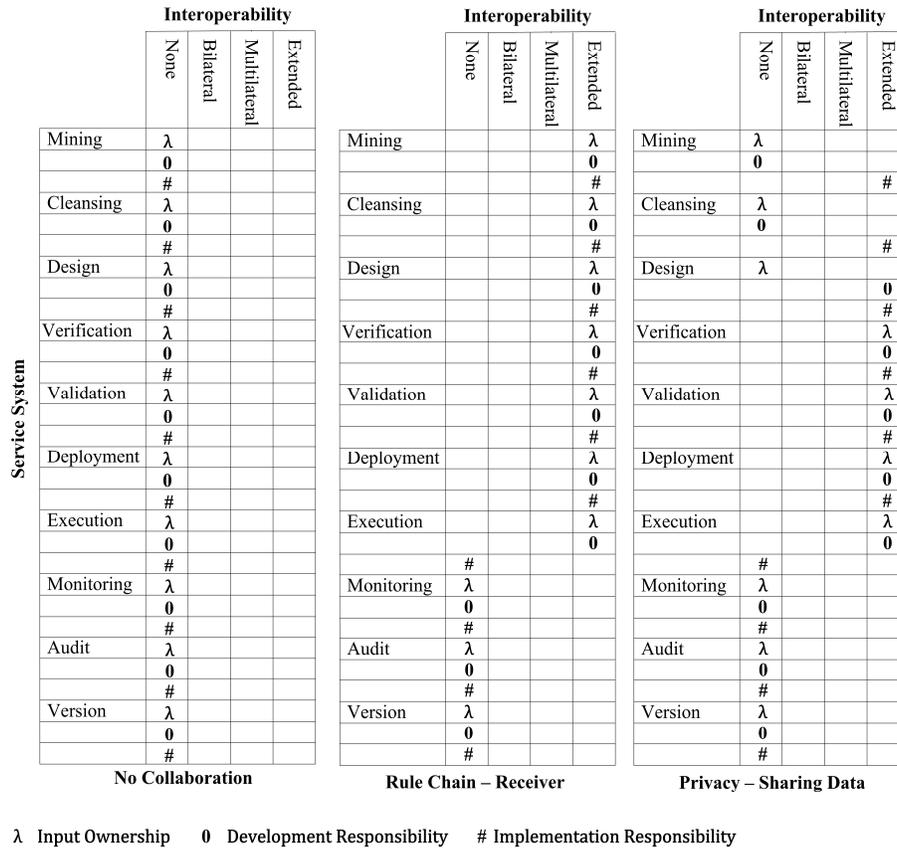


Figure 4.4: Example BRMS Configuration

4.5 Case study analysis

This case study examines the business rules that are applied to decide whether customers are allowed access to the business lounges of the airline. Each member has different business rules to decide whether customers are allowed into their business lounge. For example, FAA states that a customer must have acquired the silver status while airline MustAirlineSystem (MUS) states that the customer must have acquired the gold status. When a customer of MUS arrives at a lounge managed by FAA carrying the silver status he/she will not be

allowed access. MUS will not pay FAA to take care of the customer. Two types of events change the business rules for lounge access. First an airline changes its business rules or secondly an additional airline is allowed into the alliance. This case study explains the three phases FAA and FTW have gone through when implementing the collaborative BRMS for lounge access. Before the individual phases are explained first an evaluation of the collaborative BRMS will be presented.

Evaluation of the Lounge Access System

FAA was evaluated in terms of collaboration, privacy of shared business rules and data, rule-chain applicability, and added value of collaboration. FAA is part of an airlines alliance that governs the relationship between the individual airlines. Therefore the relationship between the airlines can be classified as a collaborative relationship with the alliance as governing body. However, business rules in general and specifically the business rules for lounge access are not governed nor formulated by the alliance. Still, from the perspective of FAA, and each individual airline, a collaborative relationship structure is in place. FAA is the governing body for its own rules which have to be deployed to multiple other organizations. Privacy of shared information is not applicable; customers agree that their information can be shared with partner airlines to provide lounge access service when becoming a member of the lounge access program. A first order party is present and a rule-chain exists. Therefore to maximally increase efficiency and assure proper execution each individual airline should deploy and implement each service system except for execution.

Phase 1: Initial Lounge Access System

In phase 1, FAA realized the non-platform specific business rules model, which is distributed to the members of the FTW alliance. To develop the non-platform specific business rules model the development and implementation of the design service system, verification service system, and validation service system are all realized by FAA. The deployment service system and execution service system are developed and implemented by the other members of the FTW alliance. This results in various platform-specific rule models, for example 1) in software source code, 2) as a ring binder with images of cards that lounges must allow access, and 3) as a copy of the non-platform specific rule models at the front desk of the lounge. This situation does not take into account that the n-order compliance index is 2. FAA does not validate the platform-specific business rules models and therefore errors can occur during deployment and execution. Enterprise Architects of FAA and FTW identified the following

which the local system determines lounge access. Although the technical implementation of the BRMS has changed, the roles and responsibilities with regard to the implementation and execution of the service system did not. Therefore the n-order compliance index is still 2. As a result the same problems occur as in phase 1. See Figure 4.5, middle column.

Phase 3: Business Rules Efficient Lounge Access System.

After the deployment of phase 2 the airlines identify that although the service-oriented architecture solution brought some efficiency problems still exists. The solution is not to transfer data from individual airlines to the local lounge management access system but to publish the decision results. The responsibility for the deployment system is now transferred to the individual airlines. This change in responsibility also leads to changes in the technical environment. Instead of a data service, decisions services are shared among the partners. See Figure 4.5, right column.

In addition to showing the application and usefulness of the method three different take aways can be identified from the case study. During the first two phases of the project the airlines focused on the wrong kind of interoperability namely data interoperability. This resulted in building interoperability solutions for data exchange while the focus should have been on business rules interoperability. The focus on data interoperability is the reason no difference, from a business rules perspective, showed in the BRMS configuration. After realizing that the focus should be on business rules interoperability the needed adjustments were made to BRMS configuration. Leaving only the implementation responsibility of the execution service system to the partner airlines.

An additional advantage of the current implementation is that airlines are no longer bound to make decision based solely on the tier-levels. The answer of the shared decision service is a "yes" or "no". The business rules applied to determine this answer are maintained by the individual airlines. Therefore they can incorporate additional business rules into the decision. An example of this is the "because, I am the wife of" pattern. If a wife of a platinum elite member (highest overall loyalty score) from MUS arrives at a lounge managed by FAA and requests access the lounge executes the decision service. The decision service has build-in business rules that recognize the wife as such and sends back a positive answer. The moment FAA adjusts their decision service, the business rules are effective for each lounge in the world. The same mechanism

has another advantage, if additional airlines want to join the alliance they need to create a decision service and share it with the existing members. Still interoperability issues occur but less than in the original situation where tier-levels and data of customers had to be shared and aligned.

4.6 Discussion and conclusion

From a research perspective our study provides a fundament for situational configuration of BRMS. In addition to situational factors related to individual organizational instantiations, analysis revealed two major situational factors: 1) privacy and 2) rule-chain. Privacy addresses the challenges of sanitizing and/or anonymizing data which is considered private. Research addressing sanitizing and/or anonymizing data has been conducted in various fields. The situational factor rule-chain, and more specific the n-order compliance concept, addresses the question which party formulates and implements the business rules. Analysis indicates that 3rd and 4th order compliance is a common grade of compliance. First order compliance is considered to be preferable from a service design and implementation viewpoint. However, first order compliance from a political, economic, social or cultural viewpoint might not be considered optimal (Legner and Lebreton, 2007). From a political viewpoint most countries distinguish between policy makers (ministries) and a central government responsible for translating and executing policies. What effects would 1st order compliance have on the political relationship? From an economic viewpoint an interesting question is: which savings can be achieved when realizing 1st order compliance? Although limited, research on economic assessment of business interoperability shows improvements in throughput, cycle time and reduction of transaction costs (Legner and Lebreton 2007).

Our study provides a method that takes into account the type of collaboration, the two situational factors, and the quality criteria. Although the method can be applied to determine an effective BRMS configuration for a specific situation, additional research can be focused on identifying specific BRMS configuration patterns. Standard patterns for standard situations like in the FAA example can be created. However, to create such patterns additional research must be conducted.

Several limitations may affect our results. First, our study described a collaborative BRMS solution relying on induction and deduction. To assess the

generalisability of a theory deduction is to be leveraged (Lee and Baskerville 2003). Although deductive reasoning has been applied by means of a case study, to further generalize findings additional case studies should be performed; we note that such a deductive validation is outside the scope of this paper. Second limitation is the number and type of BRMS solutions analyzed. While we believe our study is representative for a large number of BRMSs, most solutions analyzed are implemented in organizations based in the Netherlands, limiting generalization.

Business rules are a key denominator for an organizations success. Likewise the ability to collaborate with business partners is considered as a key denominator. The aim of this study was to provide insights into different forms of interoperability that are related to an organization's BRMS. Therefore we set out to answer the research question: *"How to configure a Business Rules Management Solution for collaboration optimization?"* In order to answer this question we conducted a workshop, survey and case study. Analysis revealed two high-level situational factors: 1) privacy and 2) rule-chain. Additionally our analysis also revealed a three step method to determine the type of collaboration for a specific BRMS: 1) Determine Partner Type, 2) Determine Quality Criteria and 3) Determine Privacy Configuration.

5 ALIGNING RISK MANAGEMENT AND COMPLIANCE CONSIDERATIONS WITH BUSINESS PROCESS DEVELOPMENT

The improvement of business processes, to date, primarily focuses on effectiveness and efficiency, thereby creating additional value for the organization and its stakeholders. The design of processes should also ensure that its result and the value obtained compensates for the risks affecting this value. In this paper the different kinds of risk affecting a business process are introduced, after which solutions to the problem of risk mitigation are discussed, resulting in a proposed framework to mollify these risks by incorporating a class of risk mitigation rules into business process development.

5.1 Introduction

Business processes are used by organizations to manage and execute their coordinated, value-adding activities and are thereby among an organization's most important assets (Rikhardsson et al., 2006). A business process realizes business objectives or goals, thereby creating value for the organization (Sienou et al., 2008). To maintain and improve the value of business processes companies implement business process management (Kettinger et al., 1997; Jeston and Nellis, 2006). From an historical perspective, the focus of business process management has been on improving business processes by making them more effective and efficient; thereby delivering increased value to the organization and its clients (Sienou et al., 2008).

However, the way in which activities are performed within a business process can bring risks with them. This risk, in turn, can reduce the value that is created by the processes, and/or create negative returns by for example regulatory non-compliance. When the risk-adjusted value of a business process, as-is or to-be, is instead considered, the overall perceived value of the process to the organization (Rikhardsson et al., 2006; Zur Muehlen and Rosemann, 2005; Jallow et al., 2007) is changed. To preserve value, the process needs to be governed, with the identified risk(s) managed in an effective way. In order to do this companies implement compliance and risk management solutions (Tarantino, 2008; Cobit, 2007).

This work was originally published as: Zoet, M., Welke, R., Versendaal, J., & Ravesteyn, P. (2009). Aligning risk management and compliance considerations with business process development. *Proceedings of the EC-Web 2009*.

Although organizations increasingly see the linkage between business process execution (Rikhardsson et al., 2006) and risk management, the two are often considered and performed as independent functions within a company (Sienou et al., 2008), just as the communities of business process design and risk management are themselves more or less separated in the scientific field (Zur Muehlen and Rosemann, 2005). In research conducted by the Open Compliance and Ethics Group, nearly two-thirds of the 250 respondents indicated having redundancy or inconsistency in their governance, risk management and compliance program resulting from the fact these were treated as individual silos, separate and distinct from (business process) execution considerations. An additional result was that this silo thinking led to higher cost and, paradoxically, increased risk (Open Compliance Group, 2008).

A tenet of this paper is that risk management considerations and business process development are closely related -- there needs to be more attention to risk-averse process design (Rikhardsson et al., 2006). Where historically the (re-)design of business processes was about creating extra value through efficiency and effectiveness we posit that it should also focus on the preservation of this value potential that a process adds to the company by more adequately identifying and controlling for the risk that is affecting proper execution of the process (Sienou et al., 2008). The research question addressed by this paper is how to integrate risk management and compliance into the (re-)design and execution of business processes?

The paper is structured as follows. Section 2 discusses the relationship between operational and compliance risk and its influence on business processes. Section 3 contains a proposed solution to the direct integration of compliance and risk management consideration into business processes. Section 4 demonstrates an application of the framework to that of a real-world regulatory compliance problem. In Section 5, a high-level overview of related research is presented. Finally, in Section 6 conclusions and suggestions for further research are discussed.

5.2 The influence of risk

In scientific research two main sources of risk can be distinguished, namely compliance risk and operational risk. Compliance (management) is defined as: "acting in accordance with established laws, regulations, protocols, standards

and specifications (Tarantino, 2008).” The risk related to compliance is caused by the failure to act in accordance with these regulatory documents. Operational risk is a form of risk caused by the failure of internal controls over people, process, technology and external events (Tarantino, 2008) to prevent “injury” to the organization (Zur Muehlen and Rosemann, 2005; Tarantino, 2008). In the existing literature these two areas of risk are discussed separately and are therefore seen as two different disciplines (Zur Muehlen and Rosemann, 2005; Carroll, 2001).

Beside the mentioned difference Carroll (Carroll, 2001) identified three differences between operational and compliance risk. First, compliance is established by external parties through the creation of regulations stating which rules a company needs to comply while with operational risk, the company itself decides which rules it wants enforce (Tarantino, 2008). With compliance risk companies have to prove, based on externally imposed criteria, that they have established a sufficient system to control the different kinds of risk. For operational risk there is no externally applied criteria or need to prove sufficient control over risk; in this case companies can implement their own criteria and create a system for measuring this (Schroeck, 2002; Standard Australia, 2004). The third distinction Carroll makes is that there can be severe consequences when the compliance program with regards to regulatory rules is ineffective or not correctly managed. The consequences with regards to operational risk are also recognized but it is believed to be not as severe. While agreeing with the first two points of difference between compliance and operational risk management given above, an argument can be made against the last. Using an example provided by (Zur Muehlen and Rosemann, 2005) the materialization of an operational risk caused the depleting of the cash reserves of a university. Another example is from the French bank Societe Generale where the materialization of an internal risk, in term of fraud by an employee, resulting in the loss of \$7 billion dollar (Societe Generale, 2008). Both examples can be seen as severe consequences from ineffective risk management on an operational level. Although the examples come from different sources, the definition of risk used in both cases is the same, i.e., as “an uncertainty, that is, as the deviation from an expected outcome (Schroeck, 2002)” whereas the state from which to deviate is either set by sources outside (regulatory) or inside (operational) the company. Below we explore the ‘business rules’-concept in order to address risk management.

To prevent activities or processes in the company significantly deviating from desired behaviors, companies create rules (Morgan, 2002; Debevoise, 2005). Rules are intended to constrain the possibilities one has to execute a task. This is achieved by stating what must be done or what cannot be done (Morgan, 2002), thereby establishing a higher degree of certainty on how a task is being performed. The rule constrains business behavior so we call it a business rule. A business rule is defined as: "a statement that defines or constrains some aspect of the business with the intention to assert business structure, or to control (influence) the behavior of the business (Morgan, 2002)." If one changes the rules on a task performed, or decision made, the consequence can be that there will be altered behavior by the individuals performing the task and/or a different outcome of the activity they are performing (Debevoise, 2005). Examples of different business rules are: (1) before opening a bank account, a person must be registered as a customer (Basel, 2003), (2) to be in compliance, you must segregate custodial and record-keeping functions (COSO, 1991), (3) it is required to pre-number documents (COSO, 1991), or (4) all financial transaction records should be retained for at least five years after the transaction has taken place (Basel, 2003).

Business rules are thus used to constrain business activities. Business processes are used to execute and control business activity. Firstly, business rules can be used as a technique within the implementation phase of a business process management design/ development lifecycle supporting the execution of the business processes (Morgan, 2002; Debevoise, 2005). In this relationship a business rules engine (BRE) can be used to support a decision within a business process where the rules define the 'how' and 'what,' and the business process defines the 'when' and 'who' (Morgan, 2002; Debevoise, 2005). The business process defines when a task or decision needs to be made and who is performing the task or making the decision, whereas the business rule restricts or decides what is going to happen in particular situation. The advantage, mostly expressed by the business rules discipline, is that the distinction in when and how something is going to happen makes processes more readable and flexible (Morgan, 2002; Debevoise, 2005). And, by having them all in one place, they can also be checked for consistency.

Secondly business rules can affect the design of the business process by affecting it at the structural level (Ghose and Koliadist, 2007), the construction level (Tarantino, 2008) and runtime level (Morgan, 2002; Debevoise, 2005). At the structural level, business rules can influence business processes in two ways

(Ghose and Koliadist, 2007). First, to conform to a rule, activities, events and/or decisions may need to be added, removed or reordered within the process. Secondly there might be a need to include or remove an actor, or re-assign tasks to different actors. At the construction level business rules influences the organizational, functional and technology elements needed for a proper execution of the process (Kettinger et al., 1997; Jeston and Nellis, 2006; Weske, 2007). Whereas the structural level focuses on the process design the constructional level focuses on the structure to support it. An example is the '(re-) construction' of human resources: appointing people to perform roles within the process.

Business rules influence the business processes at the runtime level by affecting the process execution path taken by an individual instance, also called "effect inclusion" (Ghose and Koliadist, 2007). By effect is meant the specific instance of an event that results in the change of the task/decision that needs to be performed. For example where the task is to register the data of the customer, the effect can be that the customer is a married female in which case different steps need to be taken. An effect may cause an action/decision to be permitted, mandatory or prohibited.

To comply with rules and thereby increase the risk-adjusted value of a business process, the implementation of controls that counteract risks should be put in place while implementing the process (Ghose and Koliadist, 2007; Marchetti, 2005). The controls used to reduce or eliminate these risks are called internal controls, which in this case are implemented on the level of business process (Ghose and Koliadist, 2007; Marchetti, 2005). The main distinction in internal controls is preventive and detective controls (Ghose and Koliadist, 2007; Cobit, 2007; Marchetti, 2005). Preventive controls are controls that prevent events and errors that can occur where detective controls identify events and errors that already occurred. Examples of preventive controls are controls that realize proper recording and authorization of data within the process (Tarantino, 2008; Cobit, 2007). Examples of detective controls are the monitoring and review of results from tasks performed in the process (Marchetti, 2005).

To summarize the influence of risk on business processes an overview of the relationship between the different concepts is shown in Figure 5.1, which is based on (Rikhardsson et al., 2006). As stated a business process adds value to a company. To protect this value risk management is performed on the business processes activities. One result of these risk management activities are

internal controls which are created to make the business process activities more risk averse. The internal controls and risk management activities are based on two kinds of risk namely operational and compliance risk.

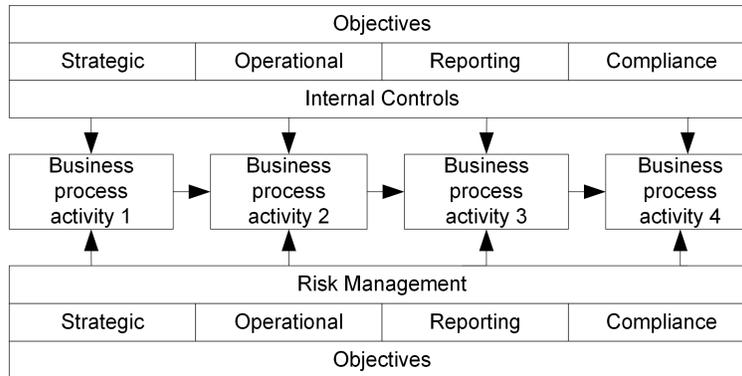


Figure 5.1: Relationship between operational risk, compliance risk, internal controls and business processes.

5.3 An integrated framework

In the preceding section, the relation between operational risk, compliance risk, internal control and business processes was established. In this section, an integrated framework to deal with this integration from a business process perspective is proposed. We proceed in two stages.

First, the categories of risk are defined from a business process perspective. Then, the integration with the business process life-cycle is provided in a framework where the risk categories are associated with the different phases of a business process lifecycle resulting in an overall process-framed, risk-management framework.

5.3.1 Categories of risk management and compliance rules

In Section 2 we discussed that rules set by law versus management can influence perspectives of a business process. In examining a diversity of operational and compliance risk and statements contained in existing literature, notably Tarantino (2008), Cobit (2007), Morgan (2002), Debevoise (2005), Ghose and Koliadist (2007) and Marchetti (2005) we were able to derive five

generic categories of rules and categorize them in a way meaningful to business process developers. These are:

Category 1: Task Sequencing. This category contains rules that have an influence on the positioning of one or multiple task/events/decision (Zur Muehlen and Rosemann, 2005) (hence process elements) within a business process. To make the process compliant with the defined rules, process elements need to be added, re-ordered or removed (Ghose and Koliadist, 2007).

Category 2: Actor Inclusion/Interaction. This category contains rules that have an influence on the assignment of tasks or decision to specific actors. To make the process compliant with rules defined actors needs to be removed/added or appointed to different elements inside the process (Ghose and Koliadist, 2007).

Category 3: Effect Sequencing. This category contains rules that have an influence on the paths chosen inside the process (Standard Australia, 2004). The path chosen is based on the values associated with individual transaction, in contrast with category 1 which influences the arrangement of the paths. An example is an insurance policy process where, depending on the age of the insured person, different process elements need to be executed. To make the process compliant, business rules need to be enforced during runtime (Morgan, 2002; Debevoise, 2005).

Category 4: Data / Information Registration. This category contains rules that have an influence on recording (Marchetti, 2005; Lientz and Larssen, 2006) and viewing data/information, and the authorizations related to this (Marchetti, 2005; Lientz and Larssen, 2006). To make the process compliant, internal controls need to be implemented that deal with (1) timing: how long must the recorded data be kept (Rikhardsson, 2006; Marchetti, 2005; Lientz and Larssen, 2006), (2) accuracy: the registered data must be in predefined format (Marchetti, 2005; Lientz and Larssen, 2006), (3): completeness, the data registered must contain the following information (Rikhardsson, 2006; Lientz and Larssen, 2006) and (4) authorization, restricting access to predefined user and roles (Lientz and Larssen, 2006).

Category 5: Detection Control. This category contains rules that have an influence on how results from events (undesirable or desired) occurring in business processes are identified (Tarantino, 2008; Standard Australia, 2004;

Marchetti, 2005). Examples include the results of two (in) dependent tasks that are compared to each other (reconciliation) (Tarantino, 2008; Standard Australia, 2004; Marchetti, 2005); results of a task or processes that are monitored for a certain value and audited (Tarantino, 2008; Standard Australia, 2004; Marchetti, 2005). To make a process compliant a multiple solutions can be used: (1) process elements can be added, reordered or removed (Ghose and Koliadist, 2007), (2) internal control can be added to the process (Tarantino, 2008; Marchetti, 2005) or, (3) a new business process can be created to perform the control (Tarantino, 2008).

5.3.2 Situating the Rule Categories in Business Process Development

As stated in Section 2, and developed further in the five categories enumerated above, risk mitigation, when converted to business rules, will influence different aspects of a business processes design, configuration, and execution life-cycle. Likewise a business process management development method deals with different perspectives of designing and configuring a process at different stages (Kettinger et al., 1997; Jeston and Nelis, 2006; Weske, 2007). The key then is to tie risk-mitigation rules to their appropriate stage of application in a business process development life cycle. Table 5-1 below outlines this association.

The first BPM-Phase identified in Table 5-1 is the (re-) design phase. Within the (re-)design phase in a BPM lifecycle, the business process is designed by assigning process elements (Kettinger et al., 1997; Jeston and Nellis, 2006; Morgan, 2002; Debevoise, 2005; Weske, 2007) and roles to it (Kettinger et al., 1997; Morgan, 2002; Weske, 2007). The rule categories identified to which the assign of these elements are seen as solutions are task sequencing, actor inclusion/interaction and detection controls. Morgan (2002) assessed the possibilities of implementing rules that affect the sequencing of the process and assignment of actors concluding that both can better be done in the design phase with regards to implementing a Business Rules Engine that controls this at runtime.

The second BPM-Phase identified in Table 5-2 is the Construction Phase that in a BPM lifecycle occurs during the creation of the infrastructure and controls to support the process (Kettinger et al., 1997). This generally means the implementation of some type of information system or business process

management platform or "suite." For example, Debevoise (2005) assessed the possibilities of implementing rules that affect the registration of data, and concluded that this is better arranged by the business processes and the way it controls the data created by it. The two categories identified that perform control on the process or the data it produces are data / information registration and detection control.

Table 5-1: A Rule Mapping Framework

Rule Category	BPM-Phase
Task Sequencing	(Re-) Design
Actor Inclusion/Interaction	
Detection Control	
Data / Information Registration	Construction
Detection Control	Runtime
Effect Sequencing	
Detection Control	

The runtime phase in a BPM lifecycle is when the process has gone live and is executed within the company (Kettinger et al., 1997; Jeston and Nellis, 2006). In this phase, the activities and decisions made within the processes need to be monitored and controlled for proper execution (Kettinger et al., 1997; Jeston and Nellis, 2006). To control and monitor the process, risk-related decisions need to be monitored at execution so that the execution of a related activity is can guided at that moment in time. The two rule categories identified that must be deferred to this stage in order to maintain risk control over the proper execution of activities within a process are effect sequencing and detection control.

5.4 Application

Generally speaking, risk control and regulatory compliance rules are first stated in some form of natural language, coming from sources internal or external to the organization. These serve as the starting point for the proposed method of application. The first step in the application of the framework, then, starts with this set of a priori rules.

We illustrate the hypothesized application (i.e. based upon the actual regulation but not a real-life organizational interpretation of it) of the framework by using rules that were taken from two different sources; namely, Basel II (2003) and COSO (1991). Basel II is a proposed framework for regulation in the banking sector and serves as an example of externally imposed regulatory compliance. The COSO framework, at this moment, is adopted by organizations as a de-facto standard for the implementation of internal controls (Marchetti, 2005). The COSO framework has been accepted by the US Securities and Exchange Commission (Marchetti, 2005) as well as the The Public Company Accounting Oversight Board (Marchetti, 2005) to realize and prove compliance with SOX.

From the Basel II documentation (Basel, 2003) a paragraph is derived stating part of the rules that should be complied to when a customer is opening a bank account: "For natural persons the following information should be obtained, where applicable: "legal name and any other names used (such as maiden name); correct permanent address (the full address should be obtained; a Post Office box number is not sufficient); telephone number, fax number, and e-mail address; date and place of birth; nationality...."

Table 5-2: Rules translation from the Basel II text

Input	Pattern	BPM-Phase
The following information should be obtained	Task Sequencing	(Re-) Design phase
legal name and any other names used (such as maiden name); correct permanent address	Data Registration	Construction

The second step is to categorize the text using the five rule categories. With regards to the Basel II text two categories can be recognized firstly a task sequencing patterns stated by the text as: "information should be obtained" indicating a task sequencing pattern. Secondly there is an enumeration of the different kinds of data that need to be recorded, indicating a data registration pattern.

With the rules identified and classified according to one the rule categories one can use the framework introduced to determine the most appropriate BPM-Phase in which to apply these derived rules. For the task-sequencing pattern the framework indicates that this is best dealt with in the BPM-phase (re-) design, refer to Table 5-2.

As a second example of how the framework can be used -this time applied to risk mitigation associated with internal controls- a subset of recommended internal controls from the COSO documentation (COSO, 1991) were analyzed using the same steps outlined above (As shown in Table 5-3). The difference with the first table is that the second input has three BPM-phases as output. The reason for this is that detection controls can be solved within multiple phases and do not have one preferred phase.

Table 5-3: Rules translation from internal controls states by COSO framework

Input	Pattern	BPM-Phase
Access to HR records is restricted to authorized personnel	Data registration	Implementation
Reconcile accounts payable subsidiary ledger with purchase and cash disbursement transactions	Detection Control	Design / Construction / Runtime
Segregate custodial and record-keeping functions	Actor Inclusion/Interaction	(Re)Design Phase

The preceding examples indicate that it is feasible to use a set of rule-categories to analyze existing internal and external controls, to convert them into business rules, and to include their implementation along the business process development life-cycle. That, in turn, achieves an usable approach to the integration between risk-management and business process management design and development considerations.

A sustainable approach towards operational and compliance risk should fundamentally have a preventative focus (Sadiq et al, 2007). Applying rules

focused on mitigating risk and achieving compliance should therefore be incorporated in the early stages of business process (re) design. The framework adheres to this by addressing rules in a stratified manner based on the phases of the business process life-cycle.

The application of the framework is twofold as it can be used to aid design and critique business processes. The framework aids process designers to integrate rules, and thereby mitigates risk, in their design by indicating the influence of the rules on different stages within the business process life-cycle. Therefore risk avoiding measures can be implemented during the design and do not have to be added after the process has been designed. In the latter situation the process designer might need to change the process after it has been designed, just to comply with regulations whereas in the first situation this is part of the design process. Secondly the framework can be used to critique existing business processes with regard to where and how business rules are currently implemented.

5.5 Reflections on related prior research

Research on integrating risk and compliance management into business processes can be divided into: architectures (Namiri and Stojanovic, 2007; Kharbili et al., 2008), techniques (Zur Muehlen and Rosemann, 2005) and methods (Karagiannis et al., 2007) all of which deal with one or more aspects concerning risk and compliance management. Architectures describe how rules can be enforced onto business process in the design and runtime phase (Namiri and Stojanovic, 2007; Kharbili et al., 2008). Techniques (Zur Muehlen and Rosemann, 2005) mostly focus on deriving and measuring the risk of certain activities (Namiri and Stojanovic, 2007; Kharbili et al., 2008), whereas methods (Karagiannis et al., 2007) deal with making a processes compliant or risk-averse.

In Namiri and Stojanovic (2007), an architecture for business process compliance is proposed. The authors argue that an automated architecture is needed to properly deal with compliance management. The input for the architecture are existing regulations that are formalized into semantic policies. From the semantic policies business rules are derived and applied to the business processes in design and runtime. The architecture describes, at a high level, how these policies are transformed but does not provide a framework or translation scheme for the rules, to deal with in the different phases. Our

research adds to this research by providing a proposal on how to translate and assign different rules to the business process development phases and recommends solutions on how to integrate the different rules.

Namiri & Stojanovich (2007) argue that the creation of a semantic layer is needed to implement compliance control on business processes. In their approach they build a semantic layer, called the "semantic mirror," on top of business processes to enforce the created rules. To do the compliance checking, the rules and business processes are translated to logical statements so that they can be compared to each other. The difference in their approach compared to that of Kharbili et al. (2008) is that it concentrates more on the design of internal controls, which are then mapped to the business processes. The mapping is done by translating the internal controls and business processes into logical statements. Our research adds value to this research in the same way as it does to the research of Kharbili et al. (2008), i.e., it provides a development framework against which the placement of the controls can be based.

In Karagiannis et al. (2007) a six-step, process-based approach to SOX compliance has been proposed. The author's second step, "Risk Assessment and Scoping," contains the identification of risk and design of internal controls to cope with these risks. As stated in Section 2 (above) different types of risk will lead to rules that cannot be enforced by design or during execution in which case the rules need to be enforced/controlled by monitoring. Our research can be an added value in this step to translate the rules to controls in a structured way.

5.6 Conclusions

In this paper we set out to find an answer to the following question: how to integrate risk management and compliance into the (re-)design and execution of business processes? In order to answer this question first we identified the difference between operational and compliance risk. Resulting to the answer that the difference lies in who states the rules, the company itself or external parties, and secondly the burden of proof to the external party related to compliance risk.

To deal with risk caused by operational execution and regulatory rules companies create rules to prevent activities or processes in the company to significantly deviate from desired behavior. The rules implemented affect business process at the structural level, the implementation level or through the fact that new business processes need to be created to comply with the rules (the design level).

We elaborated on the relationship between operational risk, compliance risk, internal controls and business processes resulting in the proposal of a framework to deal with the integration of the different areas from a business process perspective. The framework ties five identified categories of risk management and compliance rules to their appropriate stage of application in a business process development life-cycle. The application of the framework has been demonstrated by applying it to two different sources, Basel II (2003) and COSO (1991), of rules.

5.7 Discussion / Further Research

The suggested framework has its limitation. The framework is a suggested solution derived from the existing knowledge base in the area of business processes, governance, risk management and compliance and thereby the result of a 'generate design alternative' phase (Hevner et al., 2004). However, we believe that the proposed framework reached a level of maturity such that it can enter a detailed validation phase. At this moment we are conducting a survey to validate if the rule categories are exhaustive and mutually exclusive. The same validation also focus on the relationship between the different rule categories and the stages within the business process life-cycle. In future work the framework proposed will be validated through the execution of a case study to demonstrate its usefulness. Secondly a pattern language needs to be developed that can be used to parse natural text and appoint rules to the specified category. We also want to develop standard rule extractions from regulations like Basel II, HIPAA and SOX.

6 ALIGNMENT OF BUSINESS PROCESS MANAGEMENT AND BUSINESS RULES

Business process management and business rules management both focus on controlling business activities in organizations. Although both management principles have the same focus, they approach manageability and controllability from different perspectives. As more organizations deploy business process management and business rules management, this paper argues that these often separated efforts should be integrated. The goal of this work is to present a step towards this integration. We propose a business rule categorization that is aligned to the business process management lifecycle. In a case study and through a survey the proposed rule categories are validated in terms of mutual exclusivity and completeness. The results indicate the completeness of our main categorization and the categories' mutual exclusivity. Future research should indicate further refinement by identifying rule subcategories.

6.1 Introduction

Organizations execute their coordinated value-adding activities to realize business goals and thereby create value for the organization. Continuing trends as fast-changing customer demands and increased regulation urge organizations to properly manage and adapt their business models and processes. Adaption is measured in terms of agility which is the ability (Qumer and Henderson, 2006, p3) "to accommodate expected or unexpected changes rapidly, following the shortest time span, using economical, simple and quality instruments in a dynamic environment and applying updated prior knowledge and experience to learn from the internal and external environment". Agility is related to the management and execution of 1) activities and 2) decisions. The first perspective focuses on the quality, speed and yield of activities. The second focuses on the quality, speed and yield of decisions related to activities to be executed.

The management and execution of business activities and decisions is studied in the fields of business process management (BPM) and business rules management (van der Aalst, ter Hofstede & Weske 2003). Although both fields have existed for over 50 years, the last decade has witnessed an increased interest from both scientists and professionals regarding the linkage of the two

This work was originally published as: Zoet, M., Versendaal, J., Ravesteyn, P., & Welke, R. (2011). Alignment of Business Process Management and Business Rules. *Proceedings of the European Conference on Information Systems*.

(Gottesdiener, 1997). Both fields have their own history, and they approach business operations and constraints from different viewpoints. Business rules management (BRM) formulates constraints based on descriptions and facts while BPM addresses business operations from a(n) activity/resource approach. As more organizations are deploying BPM as well as BRM solutions, this paper argues that efforts should be made to synchronize both. In this, we are in agreement with Kovacic (2004) that a broader view of integrating business processes and business rules must be taken. As well, a full research agenda continues regarding business process and business rule formalization, classification and articulation (Zur Muehlen and Indulska, 2010). In this paper we focus on the classification of business rules. The specific research question addressed in this paper is: how to categorize business rules such that an integrative relationship is established with the business process development and management lifecycle? We believe that answering this question will help practitioners better integrate BPM and BRM concepts, while adding to the body of knowledge regarding business rules management by, thoroughly validating defined business rules categories.

The remainder of this paper proceeds as follows. The next section provides a context by describing business processes, BPM, business rules, BRM and related research. The third section describes the determination of rule categories and their integration in the business process lifecycle. Section four validates the identification of rule categories, presents the results of a data analysis and discusses research implications. The final section summarizes the study's core findings and contribution.

6.2 Theoretical Grounding

Business processes are used to manage and execute an organizations' coordinated, value-adding activities and are thereby among their most important assets (Rikhardson et al., 2006) or capabilities. The definition used for business process is adopted from the Workflow Management Coalition (WfMC, www.wfmc.org) and described as the "set of one or more linked procedures or activities which collectively realize a business objective or policy goal, normally within the context of an organizational structure defining functional roles and relationships". Many different practices and principles have been developed over the last century for the maintenance and improvement of business processes. Examples include: total quality management, business

process reengineering, economies of scale, just-in-time principles and performance focii (Ravesteyn, 2007). Although there are differences among these practices/principles, the main focus has been on a set of common fundamental goals namely: cost reduction, time reduction and output quality (Porter, 1985; Hammer and Champy, 1993; Prim and Trabasso, 2005; Jeston and Nellis, 2006). Recently BPM has gained much attention by management and IT departments to manage business processes. BPM originates from multiple above mentioned existing phenomena and focuses on the whole business process lifecycle (Ravesteyn, 2007). In our study, BPM is defined as (van der Aalst, ter Hofstede & Weske 2003, p. 4) "Supporting business processes using methods, techniques, and software to design, enact, control, and analyze operational processes involving humans, organizations, applications, documents and other sources of information" As with many theories and models, multiple development and management lifecycles exist within the scientific and professional literature (Kettinger, 1997; Jeston and Nellis, 2006; Weske, 2007). Although there are differences between the lifecycles three main stages can be distinguished namely; discovery, (re-)design, runtime and construction (e.g. Kettinger, 1997; Weske, 2007). Within the (re-) design phase in a business process lifecycle, the business process is designed by assigning process elements and roles to it. The construction phase that occurs during the implementation of the infrastructure to controls support of the process (Jeston and Nellis, 2006). This generally means the implementation of some type of information system or BPM platform or "suite." The runtime phase of a business process lifecycle is when the process has gone live and is executed within the company. In this phase, the activities and decisions made within the processes need to be monitored and controlled for proper execution. To control and monitor the processes, activities and decisions need to be monitored at runtime so that the execution of a related activity is guided.

The purpose of this research, as defined by the research question, is to specify a rule classification scheme that is aligned with business process life-cycle. This implicitly sets the criterion that the defined business rule types should be defined based on the concepts underlying the definition of a business process. Decomposing the definition of a business process three elements can be distinguished: (1) a structure of process elements (activities and decisions), (2) people executing the process or an individual process element and (3) output/input of the process or activity. Further, following Morgan (2002), a business rule is defined as: "a statement that defines or constrains some aspect of the business intending to assert business structure or to control the behavior

of the business". In the remainder of this section, we elaborate on current rule classifications and indicate their (mis) alignment towards business process concepts.

Domain based classification schemes use application or focus areas as dimensions to classify business rules (Ross, 1997; Karadis & Loucopoulos, 2004). Within literature two types of domain-based classification schemes can be distinguished 1) business function categorization and 2) high level business domain categorization. The first type classifies business rules based on the business function they affect, for example marketing, sales, procurement and logistics (Ross, 1997; Karadis & Loucopoulos, 2004). Whereas classification on high level business domains generally identifies categories like core business rules, productivity business rules, decision making rules and regulatory business rules (Ross, 1997). Thinking beyond departments and business functions is one of the foundations underlying BPM. Therefore domain-based classification will not assure a proper alignment between business processes and business rules.

A second dimension to classify business rules is by implementation technique. This form of classification is seen frequently in the literature addressing a specific implementation technique (Vassiliadis et al., 2000; Coltrera, 2002; Park and Choi, 2004). Examples of such techniques are software code, database (engines), business rules engines and expert systems (Ram and Khatri, 2005). Based on a single technique multiple classifications regarding various implementation forms are formulated. An example of such a classification is the Oracle CDM Ruleframe which classifies over ten different categories of database rules (Jellema, 2000). Both BPM and BRM include the selection and support of tooling. In both management principles tools are seen as a supportive factor. As such, we believe implementation technique will not support a proper classification to align business processes and business rules.

Multiple authors also define classification based on the level of specification of a business rule (Ross, 1997; Kardasis & Loucopoulos, 2004; Park and Choi, 2004). The level of specification is based on the ambiguity and possible interpretation of a statement. An example of a classification based on specification can be: policies, business rule statements, operational business rules and formal rule statements (Hay and Healy, 2000). Note that policies and laws are open for interpretation and formal rule statements can be interpreted in one way and one way only. Policies, laws as well as formal rule statements can affect every element of a business process. As such no real distinction can be made

regarding how they can or should affect a business process. We judge level of specification not to be a good classification scheme with which to align business processes and business rules.

The fourth, and probably most used, categorization is based on the intended behaviour of the specified business rule (Gottesdiener, 1997; Ross, 1997; Shao and Pound, 1999; Von Halle, 2001). Scholars and professionals alike have proposed multiple underlying taxonomies. A summary of these can be found in Gottesdiener (1997). We will not extensively elaborate on differences among Gottesdiener's specified classifications here. Rather we give a definition of the overall taxonomy underlying most categorizations: constraints, derivations and definitions. Definitions give meaning to terms, concepts and facts used within the organisation such as customer and order. Derivation represents statements that use knowledge such as terms, concepts and facts for computation and inferences. Constraints are statements limiting the actions of the actors within the enterprise as a whole.

In addition to the preceding four dimensions limited research has already been conducted on integrating business rules and business processes. To the best of our knowledge current research on the integration and alignment of business rules and business processes exists for theoretical classifications that have not been thoroughly validated (Kovacic, 2004; Kardasis and Loucopoulos, 2004; Park and Choi, 2004). For example, Kovacic (2004) proposes the use of three high level categories: global rules, activity rules and structural rules. In contrast Karadasis & Loucopoulos (2004) and Park & Choi (2004) present multiple, very detailed, taxonomies including over 15 different rule categories for the operational level. The proposed theories have limitations. Both Karadasis & Loucopoulos (2004) and Kovacic (2004) use the ECA structure for defining rules. Using the ECA structure (Karadasis and Loucopoulos, 2004 and Park and Choi, 2004) limit the possibilities when defining rules, as for example: no rules can be stated regarding the content of an order. We elaborate on current studies by classifying a rule categorization and validate its completeness and mutual exclusivity in practice.

6.3 Rule Categories

As described in the previous section a business process can be decomposed into three components (1) the structure of the process elements (activities and

decisions/gateways), (2) actors executing individual elements or the entire process and (3) output/input of the process or activity. The unit of analysis in our literature review is a business rule or other concept defining or constraining one or more of the decomposed components of a business process. During the first step of analysis no other sampling criteria were used. Databases containing journal articles, working papers, theses, dissertations and conference proceedings were searched using relevant keywords. A particular emphasis was placed on literature in business process management, business rules management, accounting, risk management, compliance management and corporate governance. In step two, all restrictions (rules) have been grouped based on the three decomposed process components. During the third step the rules grouped under 'structure of process elements (activities and decisions)' and 'output/input of the process or activity' have been further decomposed resulting into the current five rule categories: structural sequencing rule, actor inclusion rules, transactional sequencing rules, data condition rules and outcome control rules. Due to space limitation the complete matrix could not be added to the paper. A snapshot of the concept matrix has been added instead, see Table 6-1. Note that we define generic rule categories and not yet detailed subcategories. Detailed subcategories would describe rules that further decompose a main category (such as a structural sequencing rule) into multiple low-level business rules. Example of low-level business rules are: and/or split rules, and/or join rules, starting time rules and duration rules (Choi & Park, 2004). Our assertion is that a set of high level categories needs to be defined and validated before classifying subcategories. This section describes the consequent rule categories defined. To help ground these rule categories they are illustrated by an example drawn from the "Customer Due-diligence" guidelines stated by the BASEL committee (2003).

Structural Sequencing Rule (SSR). A Structural Sequencing Rule (SSR) is defined as a rule that influences the structural execution position of process elements. Each business process has an underlying blueprint indicating the sequence by which activities, events and decision elements (process elements) are executed (Kettinger et al, 1997; Jeston and Nellis, 2006; Weske, 2007).

Business rules can affect the extent to which organizations and employees are able to freely decide the blueprint they want to execute. In the literature, two high level types of SSRs can be distinguished. First there are rules that state whether a specific process element cannot or must be performed in a specific process. Secondly there are rules indicating that a process element cannot or

must be performed in a certain sequence with respect to other process elements (Ghose and Koliadis, 2007). Within the business process lifecycle the process sequence is decided upon during the (re-) design phase when the process model is developed (Kettinger et al, 1997; Jeston and Nellis, 2006; Weske, 2007).

Table 6-1: Snapshot concept matrix

Rule Category	Author	Defined Categories
Structural Sequencing Rule	Choi and Park (2004)	1) Iteration Rules, 2) Dependency Rules, 3) And/or split Rules, 4) And/or join Rules, 5) Starting time Rules, 6) Duration Rules, 7) Deadline Rules, 8) Sequence Restriction, 9) Frequency Rules, 10) Concurrency Rules, 11) Regulation Restrictions, 12) Standard Rules
	Ghose and Koliadis (2007)	1) Activity/Event/Decision Inclusion, 2) Activity/Event/Decision Coordination, 3) Activity/Event/Decision Assignment, 4) Effect Coordination, 5) Effect Modification
Actor Inclusion Rules	Awad et al. (2007)	Direct Allocation, Role-based Allocation, Authorization Separation of Duty, Case Handling, Retain Familiar Capability-based Allocation.
	Ghose and Koliadis (2007)	1) Actor/Resource Inclusion, 2) Actor/Resource Interaction
	Choi and Park (2004)	1) Resource management, 2) Regulation Restrictions, 3) Standard Rules
Transactional Sequencing Rules	Choi and Park (2004)	1) Regulation Restrictions, 1) Standard Rules
	Ross (1997)	1) Decision-Making Rule

Morgan (2002) assessed the possibility of enforcing business rules affecting sequencing of the process at runtime, concluding that the design phase has a preference above the runtime phase. Following Morgan (2002) and best practice, we assign the (re-) design phase as the proper phase to enforce SSRs. An example of a SSR is that banks within the European Union need to positively identify individuals that are none-customer of the bank before transferring funds on their behalf (BASEL, 2003).

Table 6-2: Snapshot concept matrix (continued)

Rule Category	Author	Defined Categories
Data Condition Rules	Knorr (2000)	1) Object structure, 2) Domain Restriction, 3) Persistency Rules, 4) Occurrence Rules, 5) Ownership Rules
	Ross (1997)	1) Integrity, 2) Calculation, 3) Access & Security, 4) Core Business Rule, 5) Productivity-Enhancing Rule, 6) Regulatory Rule
	Choi and Park (2004)	1) Regulation Restrictions, 2) Standard Rules
Outcome Control Rules	Choi and Park (2004)	1) Regulation Restrictions, 2) Standard Rules

Actor Inclusion Rules (AIR). An Actor Inclusion Rule (AIR) defines a rule that stating which process element an actor can or cannot execute. Process elements are performed by actors that are either humans or computer systems. Assigning non-compliant combinations of specific process elements or entire processes to actors can lead to of risk-like fraud and speculation (Marchetti, 2005; Tarantino, 2008). Therefore business rules should constrain actors/roles/persons/users (actors) executing specified process elements (Awad et al, 2007; Ghose and Koliadis, 2007; Wolter and Schaad, 2007; Mendling, Ploesser and Strembeck, 2008). Two categories of actor inclusion rules can be distinguished (Knorr, 2000; Knorr, 2001; Marchetti, 2005; Awad et al, 2007; Ghose and Koliadis, 2007; Protiviti, 2007; Wolter and Schaad, 2007; Tarantino,

2008), namely: 1) certain actors cannot or must execute certain process elements or processes and 2) an actor can or cannot execute a specific combination of process elements. Ghose and Koliadis (2007) argue the inclusion of two additional categories: 3) adding an actor/resource to the process and 4) actor/resource interaction. Although the additional categories highlight different perspectives we argue that both of the additional categories are an implicit part of appointing an actor to a process element. When a process element is assigned to an actor that actor also needs to be included in the process. Furthermore when an actor is removed from the process then the assignment of a task to that actor no longer exist. Therefore the interaction between actors and resources is being determined by the fact that actors are included in the process itself. Within the business process lifecycle, actors are appointed to process elements within the process model (Kettinger et al, 1997; Jeston and Nellis, 2006; Weske, 2007). The preferable business process lifecycle phase to enforce changes to the process model is the (re)- design phase (Kettinger et al, 1997; Jeston and Nellis, 2006; Weske, 2007). An example of an AIR is: simple identification activities as for example -- resident consumer customers can be handled by a clerk while more complex identification activities must be overseen by a senior staff member. Complex identification activities can entail trusts and third party managed accounts (Basel, 2003).

Transactional Sequencing Rules (TSR). A Transactional Sequence Rule (TSR) defines a rule that influences the decision of an individual process instance based on the case at hand. An individual business process has an underlying blueprint indicating the sequence in which process elements are executed. The blueprint indicates all possible routes a single process instance can follow. However, not every process instance will execute every possible route. The actual route followed is based on data, actors or events particular for that process instance. TSRs require information only acquired during runtime phase (Morgan, 2002; Debevoise, 2005). Certain type of customers such as politically exposed personas or non-face-to-face customers are likely to pose a higher risk to the banks operations and image. During the identification process the risk a certain customer possess is calculated based on the data at hand. The rules used to calculate the risk level of a customer is a TSR.

Data Condition Rule (DCR)s. A Data Condition Rule (DCR) defines: 1) what data needs to be stored, 2) how the data is stored, 3) how long the data is stored, 4) and which authorizations are required concerning the access and modification of the data. The importance of completeness and accuracy of data registration

is recognized within many studies (Marchetti, 2005; Tarantino, 2008). Rules influence completeness by stating which data (elements) need to be registered regarding the objects within the process (Marchetti, 2005; Rikhardson et al., 2006; Tarantino, 2008). Accuracy indicates the degree to which the stored data reflects the reality concerning an object (Protiviti, 2007; Tarantio, 2008). DCR rules influence the accuracy of data by defining the meaning of concepts and enforcing predefined structures in which the data needs to be stored (Protiviti, 2007; Tarantino, 2008). In addition to completeness and accuracy, DCRs' also influence authorization regarding the adjustment of data. Authorization, in general, consists of three parts (Rabbiti et al, 1991): (1) a subject that has an (2) authorization type for a (3) data object. The subject indicates the role or employee the authorization applies to. Authorization type indicates which actions the subject can perform. The data on which these actions can be performed are called data objects. A DCR concerning data authorization also needs to contain these three parts. Within the business process lifecycle, there's not a specific phase that can be pinpointed to address these issues (Kettinger et al, 1997; Jeston and Nellis, 2006; Weske, 2007). The reason for this is the way in which data is collected during the process. For example, if data is collected by means of manual input in computer systems, the control needs to be enforced during runtime. But when the system itself collects the data the controls already need to be available during the (re-) design phase. However (from the rule and control mechanism field) a preferable phase can be identified i.e. the implementation phase (Debevoise, 2005; Tarantino, 2005; Protiviti, 2007; Tarantino, 2008). Therefore the most preferable phase is the implementation phase. Placing DCRs in the context of a customer opening a new bank account leads to the following rules. The data a bank needs to store about the consumer are: last name, first name, date of birth and postal code. This data needs to be accurate as well as complete. As not every employee of the bank must be able to change the data of customers rules are in place defining which employees can and cannot change the data. Lastly rules are in place how the data must be stored.

Outcome Control Rules (OCR). An Outcome Control Rule (OCR) is a rule that defines how results from process elements (undesirable or desirable) occurring in business processes are identified. Previous rule categories affect the execution of a business process. However, it may be impossible or undesirable to formulate rules in such a strict manner that they hinder actors to perform their work. Additionally rules may focus on the outcome of processes or process activities because of regulation. OCRs influence the way in which processes

must be monitored. The enforcement of monitoring components within the business process lifecycle cannot be appointed to one specific phase (Kettinger et al, 1997; Morgan, 2002; Jeston and Nellis, 2006; Weske, 2007). The main reason for this is that the manner in which monitoring takes places differs from activity to activity. The outcome of an individual activity may be monitored with information systems or by hand but reconciliation as monitoring tool can be an entire process. For example, a rule within account is that reconciliation must occur between accounts payable and vendor statements (Cobit, 2007; Protiviti, 2007). We summarize the above discussion by presenting Figure 6.1 giving an overview of the preferred pairing of business process lifecycle phases and rule categories.

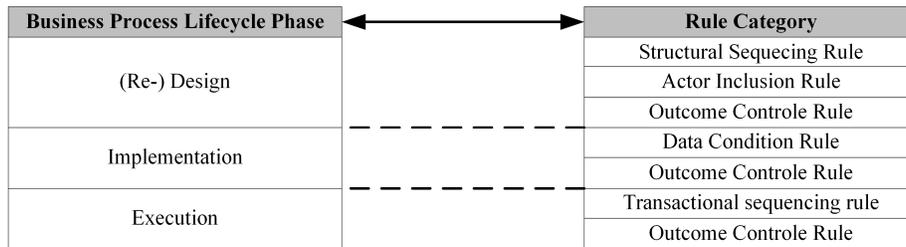


Figure 6.1: Rule categories matched to business process lifecycle phases

6.4 Data Collection and Analysis

According to the structures of Design Science, designed artifacts must be measured by predefined variables. With regards to the defined rule categorization, multiple variables can be measured such as usefulness, use, mutual exclusivity, completeness, quality and impact. As design research is a continuous cycle of building and evaluation (Hevner et al., 2004), we decided to focus on mutual exclusivity and completeness, and implicitly usefulness, before measuring other variables. The reason mutual exclusivity and completeness are measured first is because of their value regarding classifications in general. If a (rule) classification is incomplete or lacks mutual exclusivity its value decreases. The data has been collected via quantitative and qualitative analyses. Both analyses were performed in the context of risk (compliance) management as this field has an effect on business processes in its full richness. Stated differently, risk (compliance) management affects all of the individual

components of a business process such as people, information and activities (Tarantino, 2008).

6.5 Qualitative Analysis

The initial data gathering consisted of analyzing a checklist used by multiple consultancy organizations to assess risk and compliance issues: the COSO framework checklist. Recently the security and exchange commission as well as the Public Company Accounting Oversight Board accepted the COSO framework as proof of compliance with the Sarbanes–Oxley Act of 2002. The list consists of 298 elements of risks, accompanied by business rules, which can affect the proper execution of business processes. Therefore, the list provides a good foundation to assess the mutual exclusivity and completeness of our defined rules categories.

Table 6-3: Extraction Qualitative Analysis

Process	Business Rule	Category
Human Resource	Access to HR records is restricted to personnel working within the human resource department	Restriction of accessing data, Data Control Rule
Logistics	Match dates on Receiving information and Inventory information	A tasks that needs to be executed when information is received, Structural Transaction Rule
Logistics	Compare materials received, including verification of quantities received, to properly approved purchase orders	A tasks that needs to be executed when an order of materials is received, Structural Transaction Rule
Logistics	Purchase orders must contain shipment mode and delivery date	Stating which data elements need to be on plans, Data Control Rule
Funds	Reconcile accounts payable records with vendor statements	Accounts payable must be reconciled / compared to vendor statements, Outcome Control Rule.
Funds	Restrict access to accounts payable files and files used in processing cash disbursements	Restricting the access of data, Data Control Rule

The coding scheme used was designed a priori, based on the previously defined business rule categories. The initial coding scheme was subjected to one round of refinement using eleven judges. We coded all 298 elements while the remaining ten judges (reliability coders) coded 33 randomly selected risk policy statements. An extract of the coding scheme is shown in Table 6-3 above. 33 items represents 11% of the total sample size. According to Wimmer & Dominick (1997) this can be seen as appropriate number of elements for reliability coders. After the first round of coding two inter-rater reliability indexes were calculated: percent agreement and the Krippendorfs alpha, an inter-rater reliability index that measures the agreement between judges (Krippendorff, 2003). The reason for using a combination of indexes lies in the interpretation of both measurements. Percentage agreement is widely used but multiple authors indicate it is a misleading, and therefore inappropriate measure (Krippendorff, 2003) because it does not take chance into account.. Krippendorfs Alpha, on the other hand, takes randomness into account and is considered to be a more conservative measure of interrater reliability. Therefore the combination of both indexes should provide a more reliable view. The inter-rater reliability index after the first round of coding resulted in a 93.33% average agreement and a Krippendorff's alpha of .868. Both values therefore have acceptable scores as the average agreement is above 70% and Krippendorff's alpha is above .8 (Boyatzis 1998; Krippendorff, 2003). For this reason the refinement process required only one round. The combination of inter-rater reliability indexes and the fact that all 298 elements could be appointed to a specific category leads us to the conclusion that our categories can be considered complete, useful and represent mutual exclusivity.

6.6 Quantitative Analysis

The quantitative data for this study was collected by an online survey. The professionals and academic researchers that participated in the preceding qualitative analysis were excluded from this survey. Following a single round of data collection, 32 usable responses were obtained. The low response rate may be attributed to the time it took a respondent, on average, to complete the survey: 45 minutes. Forty-two percent (42%) of the respondents had over ten years of experience in the BPM and/or business rules management field. The remaining 58% of the respondents had a diverse level of expertise ranging from less than two up till nine year(s) of experience.

During the survey two constructs were measured: completeness and mutual exclusivity of the business rule categories. The first construct was measured by means of an open-ended question. After presenting the five rule categories, respondents were asked to state rules that cannot be assigned to one of these categories. The construct of mutual exclusivity was measured by presenting a list of twelve proxy values representing the five rule categories, and then asking the respondent to assign them to a rule category. To already obtain a further indication on how to enforce specific rule categories, an open-ended question was added at the end of the survey asking the opinion of the respondents regarding this topic.

Regarding the construct of completeness we found that 81% (26 out of 32 respondents) could not refute or extend the defined categories. Hence, agreeing that the five rule categories give a proper illustration of rules encountered in practice. The remaining 19% did not propose an additional category but argued the separation of event based rules from the structural sequencing categories as according to the respondents this would give an improved overview.

Table 6-4: Internal consistency respondents answers to rule categories

	Internal Consistency
Structural Sequencing Rules	0,249
Actor Inclusion Rules	0,814
Transactional Sequencing Rules	0,642
Data Control Rules	0,762
Outcome Control Rules	0,644

Mutual exclusivity can be calculated by two different indexes: percent agreement, and Cronbach's Alpha. Percent agreement measures mutual exclusivity as the percentage of respondents that appoint a single proxy value to the same category, while Cronbach's Alpha measures the consensus (mutual exclusivity) among the answers of a single respondent (Van Wijk, 2000). Although scholars debate which value to use when scaling internal consistency, a score of 0.7 or higher is considered as sufficient when using a normal to average scale of four proxy values. Our survey uses two proxy values to determine the Cronbach alpha's score, thereby negatively affecting its calculation (Van Wijk, 2000). In these situations a limited number of proxy values is used, and a Cronbach's Alpha of 0.6 or higher is considered sufficient (Van Wijk, 2000). Mutual exclusivity calculated by percent agreement resulted

in no single score higher than 40%. All, except one, Cronbach Alpha values exceeds 0.6, see Table 6-4. Indicating that consensus among answers of individual respondents exist regarding four of the five rule categories. Thus, although not agreeing amongst each other respondents appoint for four of five categories the proxy value to the same category indicating mutual exclusivity.

6.7 Conclusions and Further Research

Comparing the results from the qualitative and quantitative analysis leads to interesting conclusions. First, based on the qualitative analysis we can state that the defined rule categories are mutually exclusive and appear to be complete (collectively exhaustive) as well as indicating usefulness. Although the last two characteristics are strengthened by the results of the quantitative research, this can only partly be stated for mutual exclusivity. The answers from individual respondents are mutually exclusive for four out of five categories but the respondents do not always appoint rule statements to the 'proper' rule category. A possible explanation with regards to mutual exclusivity may be found in the time it took to complete the survey in combination with a lengthy explanation of the rule categories during the introduction. Further, after the refuting question, not having the availability of going to the rule categories.

When organizations (re-) design business processes it is fertile to already identify and define SRRs, AIRs and OCRs during the redesign phase and incorporate them in the process design. During the implementation phase process managers need to make sure that DCRs and OCRs that could not be dealt with during the (re-) design phase are included and accounted for. TSRs and remaining OCRs must be addressed during the actual execution of the designed business process. When incorporating business rules and business process (re-) design in such a manner, a higher degree of alignment can be reached.

We believe that this work represents a further step in research on synthesizing business rules (management) and business process (management). While this work has focused on validating mutual exclusivity and completeness of the main rule categories, future research should explore subcategories, related rule templates, representation of business rules in process models and the preferred business process lifecycle phase to enforce a specific rule category. As previous research already focused on some of these questions the main emphasis must

be on quantitative and qualitative research in industry. Of particular interest is the optimal balance regarding the storage of business knowledge in terms of business process and business rules based on characteristics like existing architecture and agility.

7 A STRUCTURED ANALYSIS OF BUSINESS RULES REPRESENTATION LANGUAGES: DEFINING A NORMALIZATION FORM

Business rules play a critical role during decision making when executing business processes. Existing modeling techniques for business rules offer modelers guidelines on how to create models that are consistent, complete and syntactically correct. However, modeling guidelines that address manageability in terms of anomalies such as insertion, update and deletion are not widely available. This paper presents a normalization procedure that provides guidelines for managing and organizing business rules. The procedure is evaluated by means of an experiment based on existing case study material. Results show that the procedure is useful for minimizing insertion and deletion anomalies.

7.1 Introduction

Business process management and business rules management both study the management and execution of tasks (Van der Aalst et al. 2003). However, both do so from different perspectives. Business process management (BPM) takes an activity/resources viewpoint while business rules management (BRM) approaches tasks from a guideline/knowledge viewpoint. Integrating the two viewpoints has been of interest to scientist as well as practitioners (Gottesdiener 1997, Zoet et al. 2011). Of special interest are analytical tasks that determine a decision for a specific case based on domain-specific business rules. The reason for this is that a direct relation between the two management practices can be established. On the one hand such activities are modeled and executed within business processes while on the other hand they need transactional sequencing business rules for guidance, such that consistent decisions can be made (Zoet et al. 2011). Examples of such tasks are “determine policy renewal method”, “determine candidate ranking” or “determine risk level of applicant”. Business process modeling techniques have originally not been intended to model rule component. Yet, currently a wave of BPM-systems is being released that offer both process and rules modeling techniques (Dominguez 2009, Cordys 2010, Pegasystems 2011). As more options to integrate become available and the usage of business rules modeling

This work was originally published as: Zoet, M., Ravesteyn, P., & Versendaal, J. (2011). A Structured Analysis of Business Rules Representation Languages: Defining a Normalization Form. *Proceedings of the Australian conference on information systems* Sydney.

techniques within BPM-systems increases, manageability of rules supporting business processes becomes an important issue. Also, to remain competitive, organizations are increasingly urged to adapt to changes in their business environment, representing another force that will raise manageability questions. However, scientific research with respect to business rules modeling guidelines that address manageability in terms of anomalies such as insertion, updates and deletion is scarce (Vanthienen and Snoeck 1993).

This paper extends understanding of business rules modeling guidelines by addressing manageability in terms of insertion, update and deletion anomalies based on the following premises. Similar to previous research, we consider relational theory as the foundation for our guidelines. Dissimilar to previous research, we do not focus on one specific language/visual syntax (Vanthienen and Snoeck 1993) but we start analyzing mainstream decision rules modeling languages and build our approach from this. We posit that a preferred form of structuring business rules could comprehend most common rules languages. With these premises, the specific research question addressed is: "How can transactional sequencing business rules guided analytical tasks be normalized such that optimal manageability is realized?" Answering this question will help practitioners better manage business rules that support analytical activities in business processes.

The remainder of this paper proceeds as follows. The next section provides a context by describing analytical tasks, business rules and relational theory. The third section describes the construction of the actual normalization procedure. Section four presents the results of an experiment based on case study data. The final section summarizes the study's core findings, contributions as well as its limitations.

7.2 Theoretical Foundations

The purpose of a decision or analytical task is to determine a conclusion for a specific case based on domain specific norms. In general the process of deriving a conclusion from specified norms can be described as follows (Breuker and Van de Velde 1994). First, data specific to the case at hand is collected by executing previous tasks or by consulting documents, software or other resources. This data is compared with predefined norms (transactional sequencing business rules) that are applicable to the case. This comparison

leads to a specific value that in turn contributes to formulating the decision. Consider a policy renewal process at an insurance firm in which the task “determine risk level of applicant” is executed. First data is collected from and about the applicant. Secondly this data is compared with predefined norms defined by the insurance organization. After this comparison a decision is made whether to insure the applicant and at what rate. The example and definition above demonstrate why analytical tasks are at the intersection of the BPM and BRM domain, see also Figure 7.1. On the one hand activities need to be executed and coordinated to collect data and assemble information. This being the focus of BPM, which uses methods, techniques and software to design, enact, control and analyze operational processes (Van der Aalst et al. 2003). While on the other hand specific tasks, in this case the determination of the risk levels, are guided by transactional sequencing business rules. The use of methods, techniques and software to design, enact, control and analyze business rules is the focus of BRM (Zur Muehlen and Indulska 2009).

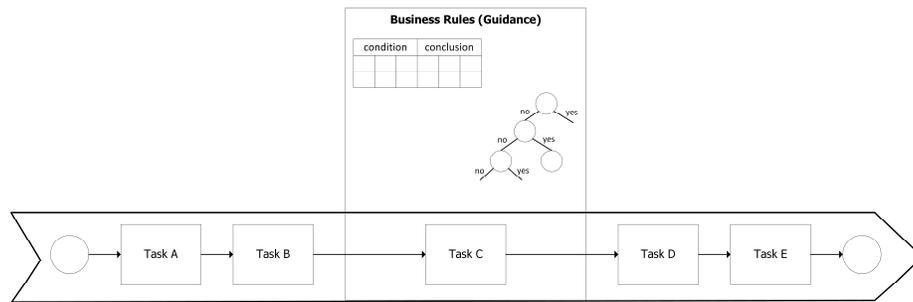


Figure 7.1: Intersection of business processes and business rules

Business rules management research as a discipline/sub-field is relatively young. Yet, the BRM sub-field can draw from research on expert systems and knowledge management which both have a rich history. Unfortunately, research executed within the field of expert systems has lost its connection with industry some time ago (Arnott and Pervan 2005). In an elaborated survey Arnott and Pervan (2005) identified this problem and list the following reasons for its existence: almost no theory refinement research is executed, poor identification of clients and users, almost no actual case studies are executed and -maybe the most important reason- research is simply focusing on the wrong application areas. One upcoming application area where there are identifiable clients and users are business rules used in the context of the analytical tasks: transactional sequencing business rules. To the best of our knowledge no

research addressing the manageability in terms of anomalies such as insertion, update and deletion of business rules has been conducted in the field of expert systems. Some research regarding this subject can be identified in the knowledge management community (e.g. Vanthienen and Snoeck 1993). Vanthienen and Snoeck (1993) report that maintainability is an issue with regards to decision tables and knowledge management systems and little research has been conducted to address this issue. In their study decision tables are used to represent business rules. Based on relational theory and database normalization they propose guidelines to factor knowledge thereby improving maintainability. However, instead of formulating one common procedure they also propose multiple exceptions to the normal forms. These exceptions have to be formulated because of the foundation of their research: decision tables. We are in agreement with Vanthienen and Snoeck (1993) that a procedure addressing anomalies should be created and that relational theory is a proper foundation. But we argue that a broader view including more business rules modeling languages should serve as a foundation to formulate such a procedure.

The definition of the term relational used in this paper is adopted from the mathematical domain, more specifically relational algebra theory (Codd 1970). Relation theory has received much attention during the last four decades, since popularized by Codd (1970) for database normalization. It states that a relationship exists (R) on a given set (S_1, S_2, S_n) if it is a set of n -tuples from which the first element is of S_1 its second element is of S_2 , and so on (Codd 1970). Most authors (Codd 1970, Kent 1984) represent such sets by means of two dimensional arrays. With this we have identified the problem we want to solve as well as the theoretical foundation for the design of the artifact. The evaluation of information system artifacts can be conducted on various elements such as functionality, completeness and performance (Hevner et al. 2004). An error common in design research is to start without clear goals in mind (Hevner and Chatterjee 2010). And even when goals are set they can be unsystematic, use incorrect measures and invalid evaluation techniques. To overcome such problems the underlying hypotheses as well as their measurements must be clear. According to this reasoning we propose the following hypotheses:

- Hypothesis 1: current decision / transactional sequencing business rules modeling languages can be translated to a unified view by means of relation theory and applied to analytical tasks

- Hypothesis 2: normalization of transactional sequencing business rules has a positive effect on the average number of tuples affected by anomalies.

7.3 Defining a normalization procedure for business rules

We consider existing decision business rules modeling languages as the foundation of our normalization procedure. Accordingly, before defining a normalization procedure first the fit between existing languages and relational theory has to be established. Establishing this fit can be broken down into three steps. First a choice has to be made which modeling languages to select for comparison. Secondly, analysis has to be conducted regarding the difference and synergy of the rules modeling languages. When a high synergy between modeling language exist it is likely that a common format for relational theory can be found. Lastly, the actual format for the relation theory has to be defined.

Since a relatively high number of business rules modeling languages exist within scientific as well as professional literature a decision, for practical reasons, has to be made which of these languages to select for our analysis. The languages chosen have the following characteristics: they are well-known/common within the field, and they have served as basis for most vendor specific and scientific languages. We consider these requirements fulfilled when (1) a language is mentioned in at least five different books randomly selected from a list of books addressing business rules (management) and (2) a language is considered as an artifact for addressing decision making issues within scientific research. During the first step ten books (Buchanan and Shortliffe 1984, Morgan 2002, Von Halle 2001, Ross 2003, Chisholm 2004, Graham 2006, Ligêza 2006, Schacher and Grässle 2006, Browne 2009, Ross 2009, Boyer and Mili 2011) were randomly selected and searched for business rules modeling languages. During the second step all modeling languages have been searched in scientific research databases to identify if the selected techniques have been applied in cases for decision making. This resulted in the following list of six languages: if-then rules (Rivest 1987), decision tables (Kohavi 1995), decision trees (Quilan 1986), score cards (Morrow et al. 2000), event, condition & action rules (Dayal 1988) and event condition action alternative rules (Heimrich and Specht 2003) which are mapped to relational theory.

Table 7-1: Representational difference analysis business rules languages

Technique	IF-Then		D-Table		D-Tree		Score C		ECA		ECAA	
IF-Then	-	-	0	2	0	2	0	2	2	4	3	4
D-Table	0	2	-	-	0	0	0	0	2	4	3	4
D-Tree	0	2	0	0	-	-	0	0	2	4	3	4
Score Card	0	2	0	0	0	0	-	-	2	4	3	4
ECA	2	4	2	4	2	4	2	4	-	-	2	4
ECAA	3	4	3	4	3	4	3	4	2	4	-	-

A technique used to identify differences and overlap between concepts or constructs in ontology's, languages and visual syntax is representational difference analysis (Hubank and Schatz 1994, Zur Muehlen and Induslka 2010). Representational difference analysis originates from medical and biological research but has since been adopted by multiple fields including information systems research (Green and Rosemann2004). The representational difference analysis of the six business rules languages is summarized in Table 7-1. Each intersection between languages contains two cells indicating the conceptual and relational differences. Conceptual difference indicates the number of non-overlapping constructs between the two languages. The difference in existing relations and plurality between concepts that are present in the two languages is displayed in the second cell. The analysis shows two clusters of languages that display high similarities. Decision tables, decision trees and score cards, only differentiate with respects to the (visual) syntax used. Underlying concepts as well as relationship are 100% identical. In addition if-then rules, event, condition& action rules (ECA) and event, condition, action and alternative rules (ECAA) also display high similarities. A closer examination reveals that the only difference between ECA and ECAA is the alternative action concept. Alternative action is a subclass of the "action" concept, which both have the same definition (Knolmayer et al. 2000). Therefore if the "alternative action" would be removed from the conceptual layer but be maintained as a visual element, the decision language still has the same expressive power. One might argue that symbol synergy is created by this (Moody, 2009) but it is quite clear which symbol to use for the first and secondary (alternative action) action.

The main difference between the two clusters of languages is caused by two concepts: event and action. An event is "something that 'happens' during the

course of a process which affects the flow and usually has a cause or an impact and in general requires or allows for a reaction (OMG2011, p113)". In terms of ECA(A) rules this reaction is an evaluation of predefined conditions (Wu and Dube 2001) leading to a conclusion. Therefore, the event is no actual part of the decision rules but triggers their execution. When executing a business process the event triggering decision business rules is an analytical task (OMG 2011, Zur Muehlen and Indulska 2010). No general consensus exists regarding the definition of an "action" with respect to ECA(A) rules. This is caused by the adaption of ECA rules in a variety of fields such as personalization technology, workflow management, rule management and database management (Bailey 2002). In addition one of the first papers (Dayal 1998) introducing the actual ECA mechanism defines an action as something that is executed. However, within BPM literature the action concept is commonly used as the execution of an actual activity (Geppert and Trombos 1998, Van der Aalst et al. 2005). Like event, action therefore is no actual part of the decision business rules. Summarizing we can conclude that a high synergy between the different modeling languages exists.

So far we did not consider relation theory. In order to do so a second representational difference analysis has to be conducted from a different perspective. The representational difference analysis as well as simplification is summarized in Table 7-2. For now it is sufficient to recognize that the table illustrates the comparison of the different relation views, the interpretation of the formulas will be explained later. Analysis shows that decision tables, decision trees and score cards have the same relational view. This is not surprising considering their meta-models are equal. The remaining three business rules decision languages all have different relational views resulting in four different relationship types. As our goal is to develop a normal form based on relational theory it is important that all languages can be represented by the same relationship (R). Because of practical reasons we do not choose to, and cannot, alter existing business rules languages. A simplification of their relational view is required. Therefore, first all business process element concepts previously identified are removed from the relationship, see Relational View 2 in Table 7-2. All six relational views are now equal with exception of the conclusion set. Three out of six modeling languages accept only one conclusion set while the others accept multiple. To provide support for every language we remove the possibility to support multiple conclusion sets resulting in Relational View 3. This relationship type therefore is also adopted as our first normal form. Thereby deviating from previous research that allows multiple conclusion facts

(Vanthienen and Snoeck1993). In order to further discuss our normalization procedure and forms first the following concepts need to be further specified: conclusion fact (Cl), condition fact (Cd), business rule and secondary conclusion. Consider the following example, a rule base that is used to decide the specific kind of joint housework for a specific citizen. Two relationships have been defined:

- $R1 = (\textit{joint housework}, \textit{caring criteria}, \textit{accommodation criteria}, \textit{exception criteria}, \textit{unanswerable presumption})$
- Relational View $R1 = (Cl, Cd^1, Cd^2, Cd^3, Cd^4)$
- $R2 = (\textit{caring criteria}, \textit{financial entanglement}, \textit{other entanglements}, \textit{relationship status})$
- Relational View $R2 = (Cl, Cd^1, Cd^2, Cd^3)$

A relationship is defined on a specific domain of facts which together represent the business rule. A business rule is an actual instantiation of the domain between brackets. A domain of facts contains one fact that is derived from the other facts within the same domain. Such facts are called conclusion facts (Cl). In the example above, "joint housework" and "caring criteria" are conclusion facts. Facts contributing to the conclusion fact are called condition facts (Cd). Commonly facts from one domain (relation) refer to facts within another domain. To provide a mechanism to address these references the concept of secondary conclusion is introduced. We define secondary conclusion as a fact that represents a conclusion fact in one domain and a condition fact in another, an example of such a fact is "caring criteria".

Our normalization procedure is based on database normalization principles following its general approach (Codd 1970). Therefore as result of the first normalization form a standard record type is created. This specific record type has already been introduced in previous paragraph: $R = (Cd^n, Cl)$. Additional demands are that both Cl and Cd facts must contain a single value. Thus, when the original source is either a decision table, decision tree or score card containing multiple conclusion fact they must be converted to 1st normal form. This is realized by duplicating the original business rules the number of times conclusions exist. All of the duplicated rules exist out of all condition and conclusion fields. The difference is that only one of the original conclusion fields is now still a conclusion field while the other are condition fields.

Table 7-2: Simplification of decision business rule classification

Technique	Original Relation View	Relational View 2	Relational View 3
IF-Then	$R = (Cd^n, Cl)$	$R = (Cd^n, Cl)$	$R = (Cd^n, Cl)$
D-Table	$R = (Cd^n, Cl^n)$	$R = (Cd^n, Cl^n)$	$R = (Cd^n, Cl)$
D-Tree	$R = (Cd^n, Cl^n)$	$R = (Cd^n, Cl^n)$	$R = (Cd^n, Cl)$
Score Card	$R = (Cd^n, Cl^n)$	$R = (Cd^n, Cl^n)$	$R = (Cd^n, Cl)$
ECA	$R = (E, C^n, CL, A)$	$R = (Cd^n, Cl)$	$R = (Cd^n, Cl)$
ECAA	$R = (E, C^n, CL, A^n)$	$R = (Cd^n, Cl)$	$R = (Cd^n, Cl)$

After realizing a standard representation the relation between conclusion and condition facts has to be normalized. In order to do so partial dependencies and transitive dependencies have to be removed (Codd, 1970, Kent 1984). The latter is realized by applying the 3rd normal while 2nd normal form deals with the first. In order for a relation to be in second normal form all condition facts must be fully functionally dependent on the conclusion fact and adhere to the 1st normal form. Condition facts not fully dependent on the conclusion facts must be deleted or added to another relationship. Second normal form reveals if condition facts are used that actually do not contribute to conclusion. To realize 3rd normal form condition facts that are not fully independent on the conclusion fact but another condition fact must be removed and added to a new relation. The new relation contains the removed condition facts as well as the fact that they are the determinants of a conclusion fact. A relationship is established between the two relations by means of a secondary decision. After applying the 3rd normal form all specified relationships do not contain any repeating groups, partial dependencies and transitive dependencies. Thereby presenting a language independent view of business rules specifying domain-specific norms for determining a conclusion. The principles described here will be validated in the next section based on existing case study data.

7.4 Normalization of decision business rules: an experiment

Based on existing case study information an experiment has been setup to test and explain the normalization procedure. The actual case study was executed at a medium sized consultancy organization. In this experiment we consider the job interview process for employing BPM-consultants; see in Figure 7.2. The first step of the procedure is to determine the scope of the decision to

normalize. During the process two analytical tasks are executed, namely "Determine Candidate Profile" and "Discuss Terms of Employment". In this section we will elaborate on the first. During this activity the candidate will be ranked based on multiple computerized and non-computerized tests s/he undertakes. The test results are input for transactional sequencing business rules that determine whether the candidate is suitable or unsuitable for the job resulting in a termination of the selection procedure or discussing terms of employment.

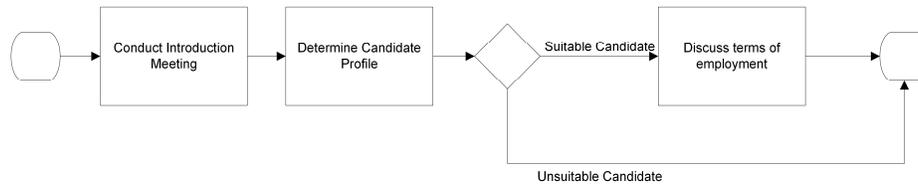


Figure 7.2: Job Interview process for BPM-consultants

After the scope has been determined for the normalization procedure the next step is the elicitation of the facts and their relationships. This can be done in several ways. First if the organization already has the condition and facts written down in text or represented in a specific visual syntax they can serve as starting point. If not, backward chaining can be applied to elicitate them. Within our sample case already three decision tables were present, see Figure 7.3.

The third step of the procedure is establishing first normal form. First normal form states that every relation can contain only one conclusion fact. In our case study this means that table A and C already are in 1stnormal form. Table B contains multiple conclusions and therefore needs to be transformed to comply with 1stnormal form. The transformation exists of creating two identical copies of the tables with two different conclusion facts:

- B.1 = (candidate integrity rating, candidate maturity rating, candidate stress management rating, candidate adaptability rating, candidate intrapersonal skills, candidate interpersonal skills, candidate age, candidate personality rating);
- B.2 = (candidate integrity rating, candidate stress management rating, candidate adaptability rating, candidate intrapersonal skills, candidate interpersonal skills, candidate age, candidate personality rating, candidate maturity rating).

Table A: Candidate Ranking

Conditions				Conclusions
Candidate Cognitive Rating	Candidate Personality Rating	Candidate Compensation Expectation	Candidate Introduction Meeting Rating	Candidate Ranking
Value	Value	Value	Value	Value

Table B: Candidate Personality Rating

Conditions						Conclusions	
Candidate Stress Management Rating	Candidate Adaptability Rating	Candidate Intrapersonal Skills	Candidate Interpersonal Skills	Candidate Integrity Rating	Candidate Age	Candidate Maturity Rating	Candidate Personality Rating
Value	Value	Value	Value	Value	Value	Value	Value

Table C: Candidate Cognitive Rating

Conditions								Conclusions
Candidate Calculus Test Score	Candidate Reasoning Test Score	Candidate BPMS Knowledge	Candidate MDA Knowledge	Candidate DBA knowledge	Mathematics Cognitive Rating	Candidate Technology Cognitive Rating	Candidate Industry Knowledge	Candidate Cognitive Rating
Value	Value	Value	Value	Value	Value	Value	Value	Value

Figure 7.3: Decision tables to determine candidate profile

Second normal form is established when all relationships are in 1st normal form and additionally all conditions that are not fully dependent on the conclusion fact are removed. The procedure is executed by determining which of the condition fields are irrelevant when formulating the conclusion and delete them. In our case study this affects relationships B.1 and B.2. Both as a result from applying the 1st normal form contain all condition facts from the original relationship B. As it is unlikely that all condition facts contribute to formulating both conclusions the relation has to be investigated. One might argue when transforming the decision table to 1st normal form already unnecessary condition facts can be deleted. Although we do not disagree when doing so the 1st and 2nd normal are applied simultaneously. Investigation of the relationships reveals that 'candidate personality rating' is determined by means of two conclusion facts namely 'candidate integrity rating' and 'maturity rating'. All other condition facts are used to determine 'candidate maturity rating' except for 'candidate age'. Considering that this condition fact also does not affect "personality rating" we remove it all together, resulting in the following relationships:

- B.1.1 = (candidate integrity rating, candidate maturity rating, *candidate personality rating*);

- B.2.1 = (candidate stress management rating, candidate adaptability rating, candidate intrapersonal skills, candidate interpersonal skills, candidate maturity rating).

Third normal form states a condition fact cannot lead to conclusion about another condition fact. All conditions that are not fully independent on the conclusion fact must be removed and added to a new decision. This procedure is executed as follows. Determine which of the condition fields is not a determinant of the conclusion field but of another condition field. In our case relationship C.1 contains multiple transitive dependencies. After removing the transitive dependencies the following relationships are defined:

- C.1 = (candidate industry knowledge, candidate technology cognitive rating, mathematics cognitive rating, candidate cognitive rating);
- C.2 = (candidate calculus test score, candidate reasoning test score, candidate mathematics cognitive rating);
- C.3 = (candidate BPMS knowledge, candidate MDA knowledge, Candidate DBA knowledge, candidate technology cognitive rating).

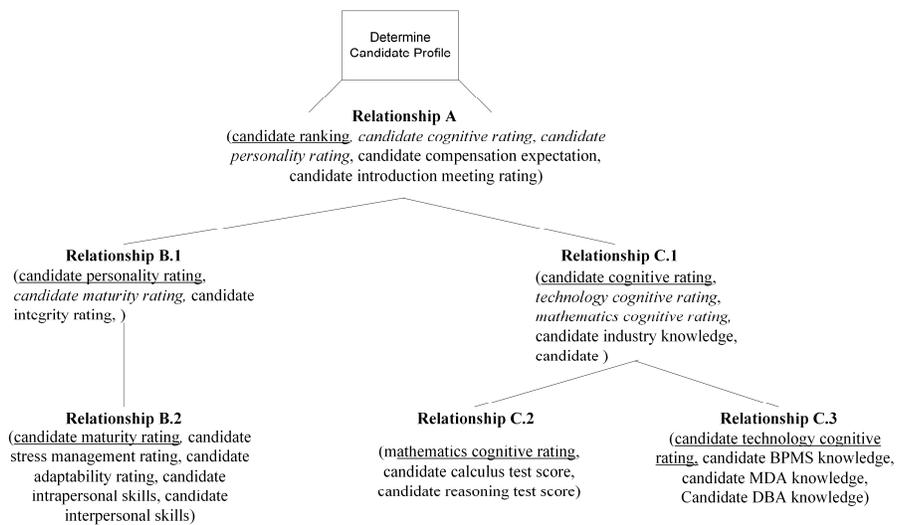


Figure 7.4: Overview normalized relational view

All relationships are now in third normal form and specified in a business rules independent language. Also the specified relationships do not contain any repeating groups, partial dependencies or transitive dependencies. The

analytical tasks and decision accompanying "Determine Candidate Profile" is shown in Figure 7.4. All conclusion facts are underlined while secondary conclusions are presented in italics.

The second part of the experiment is conducted to test our second hypothesis. To do so all possible update, insertion and delete statements based on the case at hand have been formulated and subjected to all normal forms. Due to space limitation the complete comparison is not provided here, instead a snapshot of the comparison has been added, see Table 7-3. Each row contains the action executed and the number of tuples affected in each of the normal forms.

Table 7-3: Results of anomalies experiments

Statement	Original	1 st NF	2 nd NF	3 rd NF
Update existing mathematics cognitive rating value	1	1	1	1
Update existing industry knowledge value	1	2	1	1
Update candidate interpersonal skills	1	1	1	1
Insert new rule for candidate ranking	4	4	4	4
Insert new rule for logic rating	9	9	9	3
Insert new rule for candidate personality rating	8	8	3	3
Delete existing rule candidate cognitive rating	9	9	9	4
Delete existing rule candidate maturity rating	8	8	5	5
Delete existing candidate calculus test score	1	1	1	1

A closer look at the results reveals trends regarding the normalization procedure. First the update, insertion or deletion of a single tuple affects the same number of tuples in the original as well as all normalized forms. However, one exception can be noted as shown in row three of Table 7-3. This exception is caused when transforming business rules languages that allow multiple conclusions to the 1st normal form. During this process the original business rule is duplicated the number of times conclusions exist. All of the duplicated rules exist of (all) condition and conclusion fields. The difference is that only

one of the original conclusion fields is now still a conclusion field while the other is a condition field. The removal of the duplicated facts occurs in 2nd normal form through which only one tuple is affected again. When inserting and deleting the number of affected tuples decreases, when applying 2nd or 3rd normal form. The actual tipping point depends on the kind of dependencies that exist between the facts.

7.5 Discussion and conclusion

Proper control over of anomalies such as insertion, update and deletion is crucial in order to properly structure transactional sequencing business rules that provide analytical activities with guidance. Therefore we defined the following research question: "How can transactional sequencing business rules that guide analytical tasks be normalized such that optimal manageability is realized?" We developed a normalization procedure based on representational difference analysis of existing business rules modeling languages, relational theory and database normalization. Hypothesis 1: "current decision / transactional sequencing business rules modeling languages can be translated to a unified view by means of relation theory and applied to analytical tasks" is supported by our proposed procedure. An experiment has been executed showing a decrease in insertion and deletion anomalies when applying our normalized approach, supporting hypothesis 2: "normalization of transactional sequencing business rules has a positive effect on the average number of tuples affected by anomalies."

We believe that this work represents a further step in research on business rules manageability for analytical tasks. And consequently also a step in the alignment between business rules and business process management has been made. We note however limitations that represent challenges for further research. On the methodological side, we only presented a rather small case study. Although it is expected that with larger rule sets higher savings on anomalies can be accomplished this has not been proven. As we speak, multiple larger case studies are executed to test this hypothesis. Secondly, there are additional questions regarding the economic incentives. When a decrease in anomalies and a more comprehensible rule set is realized a legitimate question is whether the procedure is or will become economically beneficial. For example, from an economic perspective, a rule set only changed twice a year might be better in an un-normalized form.

8 CONCLUSION AND OUTLOOK

8.1 Conclusion

The main research question (MRQ) in this dissertation is:

MRQ: How can business rules management be configured and valued in organizations?

Underlying the main research question two themes were addressed, i.e.: 1) the BRM problem space and 2) the position of BRM in relation to BPM design and execution. First the BRM problem space framework, as a solution for the BRM problem space, was identified. This identification makes the configuration of BRM in organizations possible. With the second theme we investigated the positioning of business rules in relation to BPM design and execution. Both themes were studied by means of theoretical and empirical research, in most cases using mixed methods.

The first addressed research question concerned the business rules problem space with identified situational factors that influence its usage:

RQ1: Which situational factors influence the configuration of a business rules management solution?

The first question concerns the identification of the problem space describing a business rules management solution and the situational factors affecting it. To answer this question, the BRM problem space framework, consisting of nine service systems, was developed and tested (chapter 2). In combination with the identified intra-organizational (chapter 3) and inter-organizational (chapter 4) situational factors the BRM problem space framework makes it possible to configure BRM solutions.

RQ1.1: What is a problem space for business rules management solutions?

To answer the first question mixed method research was conducted. The methods applied were grounded theory, a survey and a case study. Grounded theory was applied to formulate a BRM problem space framework as a solution to the BRM problem space. In total 94 vendor documents and approximately 32 hours of semi-structured interviews were analyzed. This analysis revealed nine individual service systems, in casu elicitation, design, verification, validation,

deployment, execution, monitor, audit, audit and version. Each individual service system consists of input, output and operand resources. The operand resources can be further defined in terms of organizational structure, information technology and processes. After the grounded theory study the understandability of the BRM problem space framework was tested by means of a survey. To further generalize results a case study was executed. The case study demonstrated the applicability of the defined BRM problem space framework and its usage by evaluating the BRM lifecycle. In summary, our purpose was to unravel the BRM problem space. Through mixed method analysis we have accomplished this purpose by defining the BRM problem space framework.

RQ1.2: Which situational factors describe the design of a business rules management problem space?

The instantiation of the BRM problem space by means of the BRM problem space framework answers only part of RQ1. The answer to RQ1.2 extends this with the identification of situational factors that influence the configuration of a BRM problem space framework. In total 63 project documents and approximately 18 hours of semi-structured interviews were analyzed. Analysis revealed six situational factors that influence the configuration of the BRM problem space framework: 1) value proposition, 2) approach, 3) standardization, 4) change frequency, 5) n-order compliance, and 6) integrative power of the software environment. Subsequently, analysis of these six factors using narrative comparison revealed three underlying causal structures: 1) organizational structure, 2) deep structure and, 3) physical structure. Three situational factors affect the deep structure: 1) value proposition, 2) approach and 3) standardization. Two situational factors affect the organizational structure: 4) change frequency and 5) n-order compliance. One situational factor affects the physical structure: 6) the integrative power of the software environment. The factors help to configure the business rules problem space framework.

RQ1.3: How to configure a Business Rules Management problem space for collaboration optimization?

RQ1.2 only focused on a BRM problem space within one organization. With RQ1.3 we extended our research to situational factors for an inter-organizational BRM problem space. We conducted a workshop, a survey and a

case study to collect data. Analysis revealed two high-level situational factors: 1) privacy and 2) rule-chain. Privacy indicates whether specific input data to design business rules models or the actual business rules models themselves contain data, which cannot be shared with third parties. In that case the problem space framework needs to be configured in such a way that it protects data privacy. A partner can be either a rule-chain partner or a competitive partner. Competitive partners are defined as organizational entities from the same industry realizing an identical value proposition. A rule-chain partner is an organizational entity that either formulates data sources or business rules that must be implemented by the organization or an organizational entity that should implement business rules or data sources defined by the organization. Based on both factors a three-step method is defined to determine the configuration of a BRM problem space in an interorganizational setting. The three steps of the method are: 1) determine partner type, 2) determine quality criteria, 3) determine privacy configuration. The method helps organizations to configure interorganizational BRM.

The second research question concerns the positioning of business rules management in relation to business process management.

RQ2: How does business rules management influence business process design?

RQ2.1: How to integrate risk management and compliance into the (re-)design and execution of business processes?

In the second part of this dissertation, we positioned BRM in relation to BPM. Additionally, also the relation between corporate governance, operational risk, compliance risk, internal controls, and business processes was established. Corporate governance, operational risk, compliance risk and internal controls are all management practices that influence the design and execution of business processes through the definition of business rules. To research the influence of business rules from each individual management practice research question RQ2.1 was formulated. To answer RQ2.1 a literature study (Webster and Watson, 2002) was conducted. The literature study resulted in a process-framed risk-management framework. The framework positions five different business rules types on the business process lifecycle. The five business rules categories are 1) Structural Sequencing Business Rules, 2) Actor Inclusion Business Rules, 3) Transactional Sequencing Business Rules, 4) Data Control Business Rules and, 5) Outcome Control Business Rules. All are explained in

Table 8-1. Application of the framework was tested by experiments on the Basel II Due Diligence documentation (Basel, 2003). The rules categories indicate where business rules affect business processes and consequently help to position BRM in relation to BPM.

Table 8-1: Rule category definitions

Rule Category	Definition
Structural Sequence Business Rules	Influence the structural position of activities, events and decisions within processes
Actor Inclusion Business Rules	Influence the activities an actor (person/role) can or cannot perform.
Transactional Sequencing Business Rules	Influence individual decisions within processes
Data Control Business Rules	Influence which data needs to be stored, how it is stored, how long it is stored and the authorizations concerning the access and modification of data
Outcome Control Business Rules	Influence how results from events (undesirable or desired) occurring in business processes are identified.

RQ2.2: How to categorize business rules such that an integrative relationship is established with the business process development and management lifecycle?

Although five business rules categories have been defined based on literature and experiments on the Basel II Due Diligence documentation, questions remain whether the business rules categories are complete, mutually exclusive and exhaustive. To answer these questions we conducted an extension study. The extension study is based on a qualitative study on a list of business rules formulated by a consulting organization based on the Committee of Sponsoring Organizations of the Treadway Commission risk framework, and by conducting additional surveys. Based on the qualitative analysis mutual exclusiveness of the business rules categories was supported and the categories appear to be complete and indicate usefulness. Completeness and usefulness were strengthened by the results of a quantitative research. Mutual exclusiveness however cannot be supported by the quantitative study; answers of individual respondents indicate mutual exclusiveness for only four of the five categories. The research generalized the business rules categories found in the previous

chapter. The contribution of the business rules categories to practice is a structured way of thinking about the relationship between process and business rules.

RQ2.3: How can transactional sequencing business rules that guide analytical tasks be normalized such that optimal manageability is realized?

The third research question concerned the design of one identified business rules category: transactional sequencing business rules. Transactional sequencing business rules are applied to design and define decisions. Control over anomalies such as insertion, update and deletion are crucial in order to properly structure transactional sequencing business rules. Building on work of VanThienen and Snoeck (1993) we developed a normalization procedure based on representational difference analysis of existing business rules modeling languages, relational theory and database normalization. The procedure consists of three steps: 1) apply first normalization form, 2) apply second normalization form and 3) apply third normalization form. A controlled experiment showed that normalization has an effect on the average number of business rules affected when anomalies occur. Thus, when anomalies such as updates, inserts and deletes occur the number of business rules affected in third normal form is less than the number of rules affected in first normal form.

Summarizing, the two research questions RQ1 and RQ2 answer the main research question by providing insight into 1) the configuration of the BRM problem space and 2) the relationship of BRM to BPM. The configuration of the BRM problem space provides understanding into what constitutes BRM. The BRM problem space consists of a collection of nine service systems: elicitation, design, verification, validation, deployment, execution, monitor, audit, audit and version that have to be configured. Our research has also shown that eight situational factors influence the configuration of the BRM problem space: value proposition, approach, standardization, change frequency, n-order compliance, integrative power (of information technology), partner type and privacy. The position of BRM in relation to BPM design and execution offers further insight in the configuration of BRM and provides a base for valuing BRM.

8.2 Contribution and implications

Contribution of design science research is measured by 1) new knowledge added to existing scientific knowledge and 2) new/adjusted artifacts added to the environment to solve identified problems (Hevner et al. 2004). First, the contributions and implications for academic research will be discussed, after which we describe the contributions and implications for practice.

8.2.1 Scientific Contribution

The first purpose of design research is to develop mature, precise and grounded constructs that can be added to the cumulative body of knowledge of the particular research field of focus. In turn, the body of knowledge can be used to further study constructs which become more precise over time. The use of prior knowledge to identify dependent, independent and control variables to refine the field is possible when a field has been studied extensively and can be classified as mature (McManus and Edmondson, 2007). The BRM research field is a nascent field. This dissertation added to the scientific body of knowledge by searching for repeating patterns across data sources to provide theoretical insights and to provide levers for future research. To ground our scientific contribution we refer back to the scientific relevance of our research and the position of our research theme in existing literature.

The scientific relevance identified in the introductory chapter is: *the need for BRM research from an information systems perspective that takes into account the application of BRM in practice*. Reflecting on the results of the studies we are able to provide a larger (organizational) context with respect to business rules. First, in our research we demonstrated that information technology is only one aspect of BRM. The current knowledge base contains mainly research from an information technology perspective, collectively overlooking the larger organizational context. Important additional aspects are the organizational structure and processes. The BRM problem space framework offers this larger context and can structure further research and thinking about BRM. Additional research showed that the integrative power of information technology is only one of eight situational factors that influence the implementation of a BRM problem space framework. The additional seven factors are related to the organizational structure and process design of the BRM problem space framework. The same can be recognized when analyzing the BRM problem

space framework in an extended enterprise context; technology is subordinate to the organizational perspective.

In the introductory chapter the BRM research domain is discussed from the information systems perspective and the information technology perspective. The specific lens applied in both cases is separation of concerns. We argued that BRM is only one specific lens and that relationships with other lenses must be established. In this research we positioned BRM in relation to BPM (Chapter 4, 5 and 6). Business rules guide the design and execution of business processes by constraining actors, task sequences and outcome variables. Also we positioned BRM in relation to data management by explaining how business rules constrain data to be stored. In Zoet (2009) we also present specific patterns that can be applied to formulate business rules for each business rules type. A recent paper by Caron et al. (2013) presents the likewise elements: a business rules categorization and related patterns. They distinguish between four instead of five categories. Two categories overlap with our research: the organizational process perspective (Caron et al. 2013) versus actor inclusion business rules (Zoet, 2009) and the data process perspective versus data condition rules. The remaining categories have partial overlap. In our research we distinguish between three types of process elements: activities, events and products. Caron et al. distinguish between the function perspective (process elements perspective) and the control flow perspective. Within the functional perspective Caron et al. do not propose a further decomposition. The patterns they propose to be part of the control flow perspective are the patterns we assigned to both function perspectives (activities and events) thereby not recognizing the control flow as a different category. Transactional sequence rules are not presented by Caron et al. because these are not part of their research scope.

During our research on structuring business rules through a normalization procedure, we were pointed to a newly released book on Decision Management written by Von Halle and Goldberg (2010). Both Von Halle and Goldberg's (2010) normalization procedure as well as our own normalization procedure are based on ideas proposed by VanThienen and Snoeck (1993). Therefore both normalization methods show similar steps and procedures. Still an important difference exists between the method proposed by Von Halle and Goldberg (2010) and our own method. Currently multiple business rules modeling languages are applied to structure decisions. Example formalisms are: decision tables, score cards, event condition action formalisms and decision trees (Boyer

and Mili, 2011). Von Halle and Goldberg (2010) only support decision tables; our normalization procedure supports all of the mentioned formalisms.

8.2.2 Contribution to practice

The second purpose of design science research is to develop new artifacts to solve specific problems in the environment (Hevner et al., 2004). This dissertation resulted in four main artifacts: the BRM problem space framework (as a solution for the interorganisational BRM problem space), a BRM interoperability framework, a categorization of business rules, and a business rules normalization procedure. For each artifact we will discuss its contribution to practice.

While the construction of the BRM problem space framework is still in its early development stages several organizations are already using it to position their current BRM solution. They incorporate the framework in their internal operations. The BRM problem space framework serves as a diagnostic tool for an organization's BRM solution. It offers a model that structures efforts for the implementation of BRM-based solutions. The contribution of the BRM interoperability framework to practice is that it structures thinking about roles, responsibilities, and technical implementations for BRM in the context of interorganizational collaboration.

Research on business rules categories and the positioning of BRM in relation to BPM is currently applied at multiple organizations and vendors. Our scientific work as described in chapters 5 and 6 has formed the basis for several vendor white papers, vendor presentations and professional book chapters. One vendor in particular (Bosch Software Innovations) has incorporated the results in its software-suites and discovery processes. They state (Debevoise, 2011; 2010; 2013) "*understanding the five operational decision categories simplifies the choice of what should be dynamic operational decisions supported by business rules and what should be a static part of the process [...] In summary, from the perspective of governance, risk and compliance, the five categories define an outline of the process.*" The contribution of the business rules categories to practice is a structured way of thinking about the relationship between processes and business rules. This structured way of thinking has a number of implications for information technology development. First, it supports dividing business rules into categories and subsequently it categorizes related information technology. For example, data control rules can be implemented as

stored procedures, structural sequence rules are implemented in a BPMS and transactional sequence business rules are implemented within a business rules engine. This in turn has resulted into the redesign of application architecture. Furthermore, an additional business rules management component has been build; this management component can deploy formulated business rules to various software components that must execute them. In addition, for each business rules category patterns have been developed that help organizations to elicitate business rules (Zoet, 2009). For one specific business rules category, in casu transactional sequence business rules, the normalization procedure contributes to practice by offering a method to normalize business rules and structure decisions. The method helps organizations to structure the 'big-bucket-of-business-rules' into comprehensible 'chunks'. Structuring business rules in comprehensible chunks has the advantage of improved/better control over anomalies such as insert, update, and delete.

In addition to the individual contributions of the four artifacts two additional general contributions are made to practice. First we were invited to present the BRM problem space framework and the application of the five business rules categories at several professional conferences in the Netherlands and abroad. For example, the BRM Masterclass at the 7th Edition of the Kluwer Conference on Business Process Management (Kluwer, 2012), the Business Rules Value Proposition at BPM 2012 (BPMCongres, 2012), GRIP on Business with Business Rules at the Mavim Quality Management Seminar (Mavim, 2013), and the Value of BRM at Trends in BPM 2011 (BIM Magazine, 2011). Also based on this dissertation two BRM courses as well as a decision modeling course have been developed (Master of Informatics, 2013; Business IT & Management, 2013).

8.3 Limitations

In this section we reflect on this dissertation. First we consider the limitations of our research in terms of internal validity, external validity and construct validity. Second we will explore directions for further research.

Internal validity concerns factors that affect the outcome of the research. First, data collection and data analysis with respect to the BRM problem space have been conducted by one lead researcher and five reliability coders. Introducing multiple coders in the process reduces the tradition and paradigm of a single researcher and improves the breadth and depth of the findings (Deniz, 1987;

Mays and Pope, 1995). In our research multiple reliability coders were used for data collection and data analysis with respect to the BRM problem space and the business rules categories (Chap. 2 and Chap. 6). Data analysis to identify situational factors for the BRM problem space framework (both within an organization and between organizations) was executed by one researcher (Chap 3. and Chap 4.). According to some scholars this is preferred (Morse, 1994; Janesick, 2003), yet we agree with other scholars that the tradition and paradigm of the researcher influence the results, therefore limiting internal validity.

External validity concerns factors that affect generalizability of the research (Lee & Baskerville, 2003). Generalizability of this dissertation is at least affected by two characteristics. The first characteristic is the geographical locations where data was collected. The BRM problem space framework is based on data collected from organizations based in the Netherlands. The same applies to the situational factors affecting the configuration of the BRM problem space framework. We therefore cannot merely assume that results can be transferred to other countries, limiting generalization. To validate the identified business rules categories (Chap 5. and Chap 6.) data was collected by means of a survey and case study data. Although the survey was filled in by people around the world, response was limited, thereby limiting generalization. The case study data used came from organizations that complied with the Sarbanes-Oxley Act or used the COSO framework. Data for the case study is therefore merely valid for organizations listed at a United States Stock Exchange and organizations applying the COSO framework for risk management, thereby also limiting generalization. The second characteristic of the research that affects generalizability is the state of BRM research. The BRM research domain, from an information systems perspective, is in its nascent state. We therefore studied BRM from several perspectives. Due to the state of the research domain and the need for studying the domain from several perspectives the main research question was formulated relatively broad. The trade-off for this broad setup is that a number of aspects were only slightly touched upon. In the end our findings were only applied to a limited number of cases.

Construct validity refers to establishing correct operational measures for the concepts being studied. Three chapters apply grounded theory methods and techniques therefore building constructs from collected data. During this process constructs were tested against the domain in which the construct was found, thereby increasing construct validity. The reason for this is that when

observed measures do not correlate with observable measures for the same construct the construct is adapted. This process stops when saturation occurs and observed measures correlate with observable measures for the same construct. The only way to further assess construct validity is through the use of deduction (Lee & Baskerville, 2003). Although deductive reasoning has been applied during this study, it is limited to specific geographic areas. To further generalize the models and constructs a deductive validation outside the current units of analysis should be conducted.

8.4 Reflection

In this section, we reflect on the individual chapters and the dissertation as a whole, and elaborate on some of the key decisions made across and within different chapters.

In chapter 2 we defined the BRM problem space, the problem space framework and individual service systems. As a concept the BRM problem space and underlying service systems have proven valuable by providing a perspective on BRM from a process, information systems and actor perspective. In light of these results three important issues remain unanswered. We do not provide patterns or templates to configure related business processes and information systems. Nor do we provide actor profiles. In chapter 4 we provide architectural configurations for service systems implemented in an interorganisational context and in chapter 7 we provide business process templates for the design service system. Still we acknowledge that these results are limited and further operationalization is needed.

In chapter 3 we reviewed BRM projects to identify situational factors. In total six situational factors have been identified. For each situational factor instantiations were formulated. Although collected data allows us to define detailed instantiations for several situational factors, for example value proposition, we have chosen to apply a low level of granularity. We recognize that the low level of granularity influences research results and further analysis and study needs to take place to define a more detailed classification.

In chapter 5 and 6 we positioned business rules in relation to business processes. Recall we define a business process as (WFMC, 2010): "a set of one or more linked procedures or activities which collectively realize a business

objective or policy goal, normally within the context of an organizational structure defining functional roles and relationships.” The definition still remains valid today. However, various vendors (e.g. Be Informed, 2013; Pega Systems, 2013) and researchers (e.g. Joosten, 2011) alike have adopted a business rules approach to design, implement, and execute business processes. This approach implies that during design business rules are formulated which constrain the various elements of a business process. During the actual execution the process is inferred from the defined business rules. We do not believe this approach will influence the defined categories. Since business rules still affect the order of activities and the manner in which decisions are made. However, the use of business rules to define business processes influences the relationship between the business rules categories and the business process lifecycle. Therefore our research is limited to procedural business process model languages. Business process model are procedural when the execution scenario is explicit and designed within implicit business constraints. An example of a procedural business process modeling language is the Business Process Modeling Notation (OMG, 2011).

Reflecting on the dissertation as a whole and the type of research we highly recommend a strong connection between academia and industry. The field of BRM is a relatively young and volatile field. New developments follow each other rapidly and new insights occur daily. For example three recent developments occurred in the finalization stage of this dissertation are: The Tax and Customs Administration of the Netherlands released a vision and method to realize agile execution of laws and regulation (Dulfer and Straatsma, 2013). De Blauwe Kamer, an initiative of government agencies, universities and industry, presented their management and architectural vision on BRM (De Blauwe Kamer, 2013). On august 23rd , 2013, the Object Management Group (OMG) has released the proposal for the Decision Model and Notation (DMN) Specification 1.0 (Object Management Group, 2013). These examples show a maturing BRM field. Still many questions need to be answered and new questions are formulated daily, providing input for scientific research.

8.5 Future research

Like the saying that a journey of a thousand miles starts with a single step, so does the growth of the BRM research field. BRM from an information systems perspective is a nascent research field. To grow to a mature field in our opinion

many steps still need to be taken. From this dissertation multiple opportunities for further research can be identified.

First, two high-level opportunities regarding the limitations of our own research can be identified: 1) replication studies and 2) extension studies. Further steps of development and validation are needed in the construction of the BRM problem space framework such that it can reach a, from a research perspective, more mature state. In addition, replication and extension studies for the BRM problem space framework and business rules categories are needed to increase generalization in terms of usefulness and mutual exclusiveness. In addition to these high-level research topics we also discuss three specific areas of further research.

In this dissertation BRM is viewed from an 1) organizational structure, 2) deep structure and, 3) physical structure. With respect to organizational structure and physical structure no standardization or known methods and techniques for analyzing, designing, and validating business rules exists. Such standards do exist in BPM literature; examples are Lean, Six Sigma, Total Quality Management, and should-be process mapping (Deming, 1982; Kwak, 2006). Further research can also focus on determining, creating and validating suitable methods and techniques for BRM. With respect to the deep structure and physical structure limited standardization exists. Existing standardization are Semantics of Business Vocabulary and business Rules (SBVR), Decision Modeling Notation and Production Rule Representation (OMG, 2008; OMG, 2009). The Decision Modeling Notation explicitly focuses on transactional sequence rules while SBVR has no specific focus and it used to capture all types of business rules. Further research can focus on determining suitable representation techniques for each rules category.

Our research has focused on situational factors affecting a BRM solution. However, each organization experiences further limitations of freedom through situational factors. We argue that in addition to further research on situational factors affecting the BRM problem space framework also research on situational factors affecting the actual implementation can be executed. Thereby increasing insight into BRM implementations.

Research with respect to business rules categories has focused on validating mutual exclusiveness and completeness of the main rules categories. However, organizations already start to build upon this research by trying to specify

patterns for each rules category. Thereby initiating another cycle of design science research. Further research can therefore explore business rules templates and representations of specific business rules categories in business process models.

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SUMMARY

Business rules are among the fastest changing business concepts in many organizations. The frequency of change is caused due to changing customer demands, changing regulation, increased regulation, and changing strategies. At the same time questions for more transparency are emerging, thus enforcing explanation of the applied business rules in a specific situation. In the current body of knowledge, Business Rules Management (BRM) is often classified as a technical solution. This perspective views BRM as an assembly of software with its associated hardware infrastructure, supporting the BRM lifecycle. Yet, it is the combination of methods, processes, actors and technology that deliver the value proposition. Research focusing on improving BRM practices and its value proposition is still nascent. Therefore, the main question in this PhD thesis is: How can business rules management be configured and valued in organizations?

BRM is a complex domain; in order to provide a structure for a body of knowledge for business rules management, we propose the BRM problem space framework, existing of service systems, as a solution to the BRM problem space. In total 94 vendor documents and approximately 32 hours of semi-structured interviews were analyzed. This analysis revealed nine individual service systems, in casu elicitation, design, verification, validation, deployment, execution, monitor, audit, and version. Each individual service system consists of input, output and operand resources. The operand resources can be further defined in terms of organizational structure, information technology and processes. After a grounded theory study the understandability of the BRM problem space framework was tested by means of a survey. To further generalize results a case study was executed. The case study demonstrated the applicability of the defined BRM problem space framework and its usage by evaluating the BRM lifecycle. Further research has shown that eight situational factors influence the configuration of the BRM problem space.

Business Process Management (BPM) and BRM both focus on controllability of business activities in organizations. Although both management principles have the same focus they approach manageability and controllability from different angles. BRM formulates constraints based on descriptions and facts while BPM addresses business operations from a(n) activity/resource angle. As more organizations are deploying BPM systems as well as BRM systems, efforts should be made to synchronize both. In the second part of this dissertation, we positioned BRM in relation to BPM. Additionally, also the relation between

corporate governance, operational risk, compliance risk, internal controls, and business processes was determined. Corporate governance, operational risk, compliance risk and internal controls are all management practices that influence the design and execution of business processes through the definition of business rules.

To answer the question: "*How is BRM positioned in relation to BPM?*", a literature study was conducted. The literature study resulted in a process-framed risk-management framework. The framework positions five different business rules types on the business process lifecycle. The five business rules categories are 1) Structural Sequencing Business Rules, 2) Actor Inclusion Business Rules, 3) Transactional Sequencing Business Rules, 4) Data Control Business Rules and, 5) Outcome Control Business Rules. The rules categories indicate where business rules affect business processes and consequently help to position BRM in relation to BPM. Although five business rules categories have been defined based on literature and experiments on the Basel II Due Diligence documentation, questions remain whether the business rules categories are complete, mutually exclusive and exhaustive. To answer these questions we conducted an extension study. The extension study is a qualitative study on a list of business rules formulated by a consulting organization based on the Committee of Sponsoring Organizations of the Treadway Commission risk framework, and by conducting additional surveys. Based on the qualitative analysis mutual exclusiveness of the business rules categories was supported and the categories appear to be complete and indicate usefulness. Completeness and usefulness were strengthened by the results of a quantitative research. Mutual exclusiveness however cannot be supported by the quantitative study; answers of individual respondents indicate mutual exclusiveness for only four of the five categories, falsifying Structural Sequencing Business Rules.

Transactional Sequencing Business Rules are applied to design and define decisions. Control over anomalies such as insertion, update and deletion are crucial in order to properly structure Transactional Sequencing Business Rules. Building on work of VanThienen and Snoeck (1993), we developed a normalization procedure based on representational difference analysis of existing business rules modeling languages, relational theory and database normalization. The procedure consists of three steps: 1) apply first normalization form, 2) apply second normalization form and 3) apply third normalization form. A controlled experiment showed that normalization has an effect on the average number of business rules affected when anomalies occur.

Thus, when anomalies such as updates, inserts and deletes occur the number of business rules affected in third normal form is less than the number of rules affected in first normal form.

The purpose of design research is to develop mature, precise and grounded constructs that can be added to the cumulative body of knowledge of the particular research field of focus. In turn, the body of knowledge can be used to further study constructs which become more precise over time. This dissertation added to the scientific body of knowledge by searching for repeating patterns across data sources to provide theoretical insights and to provide levers for future BRM research.

NEDERLANDSE SAMENVATTING

In veel organisaties behoren bedrijfsregels tot de snelst veranderende concepten. De hoge frequentie waarin bedrijfsregels veranderen wordt veroorzaakt door snel veranderende klantenwensen, wetgeving en strategieën. Tegelijkertijd vindt er een beweging plaats waarin meer transparantie over de bedrijfsvoering wordt geëist. Deze beweging dwingt organisaties om aan te kunnen tonen welke bedrijfsregels in welke situaties zijn toegepast. Om bedrijfsregels aan de steeds veranderende eisen te laten voldoen, dient een gestructureerde methode toegepast te worden genaamd: business rules management. In de huidige wetenschappelijke en vakliteratuur, wordt **Business Rules Management (BRM)** vaak als een louter technische oplossing beschouwd. Vanuit dit perspectief is BRM de combinatie van verschillende software elementen, met de bijbehorende hardware infrastructuur, om de BRM levenscyclus te ondersteunen. De methoden, bedrijfsprocessen en organisatorische structuur die benodigd zijn om een BRM oplossing te realiseren, zijn tot dusver nog nauwelijks of gefragmenteerd onderzocht. De hoofdonderzoeksvraag in dit proefschrift is daarom als volgt: *"Hoe kan business rules management worden geconfigureerd en gewaardeerd?"*

Aangezien BRM een complex domein is richt het onderzoek zich op het definiëren van een referentieraamwerk voor BRM. In het BRM referentieraamwerk worden negen service systemen beschreven: elicitering, ontwerp, verificatie, validatie, implementatie, executie, monitoring, audit en versiebeheer. Elk individueel service systeem bestaat uit input, output en operationele benodigdheden. De operationele benodigdheden worden verder onderverdeeld in organisatiestructuur, informatie technologie en processen. Het BRM referentieraamwerk is opgesteld op basis van de analyse van 94 documenten en ongeveer 32 uren aan semi-gestructureerde interviews. Vervolgens is het referentieraamwerk gevalideerd op basis van de volgende punten: begrijpbaarheid, volledigheid en bruikbaarheid door middel van een survey en een case studie. Deze validatie wees uit dat het BRM referentieraamwerk kan worden toegepast voor de evaluatie van een BRM probleem. Verder onderzoek heeft aangetoond dat een instantie van het BRM referentieraamwerk door acht situationele factoren kan worden beïnvloedt.

BRM staat niet op zichzelf, maar heeft nauwe relaties met andere management disciplines, waaronder **Business Proces Management (BPM)**. BPM en BRM focussen beide op het beheersen en controleren van activiteiten in organisaties. Ondanks dat beide management disciplines in principe dezelfde focus hebben,

verschillen ze wel in aanpak. Gezien het feit dat steeds meer organisaties BRM (technologie) en BPM (technologie) combineren, is het noodzakelijk om te kijken hoe beide disciplines gecombineerd kunnen worden. In het tweede deel van deze dissertatie positioneren we BRM ten opzichte van BPM. Daarnaast worden beide disciplines gepositioneerd ten opzichte van corporate governance, operationeel risicobeheer en compliance.

Om de positionering van BRM ten opzichte van BPM te bepalen is eerst een literatuuronderzoek uitgevoerd. Dit literatuuronderzoek heeft geleid tot de creatie van een proces georiënteerd risicoraamwerk. In dit risicoraamwerk worden vijf verschillende type bedrijfsregels gepositioneerd ten opzichte van de levenscyclus van een bedrijfsproces. De volgende vijf typen bedrijfsregels worden onderscheiden: 1) bedrijfsregels voor structurele rangschikking, 2) bedrijfsregels voor organisationele structuur, 3) bedrijfsregels voor beslissingen, 4) bedrijfsregels voor data verwerking, 5) bedrijfsregels voor gebeurtenissen. Door middel van een survey en case studie zijn de vijf typen bedrijfsregels gevalideerd op de punten bruikbaarheid, exclusiviteit, en compleetheid. Validatie wijst uit dat de vijf categorieën bedrijfsregels bruikbaar en compleet zijn. Exclusiviteit is aangetoond voor vier van de vijf categorieën, de data sluit categorie 1 "bedrijfsregels voor structurele rangschikking" uit.

Als laatste richt het onderzoek zich op één specifieke categorie bedrijfsregels, namelijk: bedrijfsregels voor beslissingen. Bedrijfsregels voor beslissingen worden gebruikt om beslissingen te definiëren. Bij het definiëren van beslissingen is het van groot belang dat het invoeren van nieuwe bedrijfsregels, het wijzigingen van bedrijfsregels en het verwijderen van bedrijfsregels zo efficiënt mogelijk gebeurd. Gebaseerd op het werk van Vanthienen en Snoeck (1993) hebben we een normalisatie procedure voor bedrijfsregels voor beslissingen ontwikkeld. Op basis van een gecontroleerd experiment hebben we laten zien dat normalisatie een positief effect heeft op het gemiddelde aantal geraakte bedrijfsregels wanneer een wijziging plaatsvindt.

Het doel van design research is het ontwerpen van volwassen, precieze en gefundeerde concepten die kunnen worden toegevoegd aan de 'body of knowledge' van een specifiek onderzoeksveld. De 'body of knowledge' kan op zijn beurt weer gebruikt worden om de constructen verder te onderzoeken die daardoor steeds nauwkeuriger worden. Door bedrijfsregels vanuit verschillende invalshoeken te bekijken, vergroot dit proefschrift de wetenschappelijke en praktische 'body of knowledge' over BRM en legt daarmee een basis voor verder wetenschappelijk onderzoek naar BRM.

CURRICULUM VITAE

Martijn Zoet was born on November 26th, 1983 in Nunspeet, the Netherlands. From 2004 to 2007, he studied Business Informatics at Windesheim University of Applied Sciences. He obtained his Master's degree in Business Informatics from Utrecht University in 2009. His Master's thesis, entitled "Aligning Governance, Risk Management and Compliance with Business Process Development through Business Rules" was nominated for the Business Process Management Awards.

In 2010 he joined HU University of Applied Sciences Utrecht where he currently holds the position of researcher, lecturer and coach. In the same year, he started his PhD research as an external researcher at Utrecht University.

Martijn is a board member of the Dutch Business Rules Platform, which is a society for business rules professionals and researchers in the Netherlands. Furthermore, he has fulfilled the role of reviewer for numerous journals and conferences such as ECIS, ACIS, AMCIS and PACIS.