JITTA

JOURNAL OF INFORMATION TECHNOLOGY THEORY AND APPLICATION

ISSN: 1532-3416

Identifying Challenges in Business Rules Management Implementations regarding the Elicitation, Design, and Specification Capabilities at Dutch Governmental Institutions

Koen Smit
Chair Digital Smart Services
HU University of Applied Sciences Utrecht
Koen.smit@hu.nl

Martijn Zoet
Chair Optimizing Knowledge-Intensive Business Processes
Zuyd University of Applied Sciences
martijn.zoet@zuyd.nl

Johan Versendaal
Chair Digital Smart Services
HU University of Applied Sciences Utrecht
johan.versendaal@ou.nl

Abstract:

Proper decision making represent one of an organization's most important capabilities. To manage decisions and underlying business rules, an increasing number of organizations have begun to use business rules management (BRM). However, given BRM research's and practice's nascence, we need to more deeply understand the challenges in implementing BRM capabilities. As such, from collecting and analyzing two three-round focus groups and two three-round Delphi studies, we identified 28 main challenges that five Dutch governmental institutions experienced in eliciting, designing, and specifying business rules. We also discuss directions for future research.

Keywords: Business Rules Management, Implementation Challenges, Government, Capabilities.

Felix Ter Chian Tan acted as the senior editor for this paper.

1 Introduction

As information technology has changed over the years, scholars and practitioners have separated various concerns from information technology as a whole: data in the 70s, user interfacing in the 80s, and workflows/processes in the 90s (van der Aalst, 1998). Recent research (Boyer & Mili, 2011; Zoet, 2014) shows that "business rules" will logically follow next. Specifically, business process management and business rules management both study the management and execution of tasks (van der Aalst, ter Hofstede, & Weske, 2003); however, they 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. Both management disciplines are growing closer towards each other (Gottesdiener, 1997; Zoet, 2014) given that organizations that properly implement BPM as and BRM may produce considerable benefits (e.g., building compliance into the fabric of the organization while realizing flexibility for change).

Currently, a broad body of literature on implementation challenges and critical success factors of BPM exists. Taking a broad perspective on the topic, Bandara, Indulska, Chong, and Sadiq (2007) and Sadiq, Governatori, and Namiri (2007) investigated the major challenges that three different stakeholders experienced: vendors, experts, and users. Furthermore, Vom Brocke et al., (2014) focus on the ten principles of good process management. In addition to this broad perspective, researchers have also examined specific target groups, such as governments (Lönn & Uppström, 2013) or Australian organizations (Indulska, Chong, Bandara, Sadiq, & Rosemann, 2006). Another category of research focuses on particular factors in BPM implementations. For example, Reijers (2006) focuses on how process orientation affects BPM implementation, Eikebrokk, Iden, Olsen, & Opdahl (2011) focus on factors that influence the acceptance and usage of process modeling, and Jeston and Nelis (2014) focus on how governance affects BPM implementations.

However, little to no work research has examined the challenges in BRM implementations despite the fact that wrongfully implementing BRM can greatly affect whether an organization achieves its goals. Furthermore, when an organization does not properly identify and understand the associated challenges, it lowers the chances that it will implement BRM successfully (Bandara et al., 2007). When analyzing the research on business rules (concern) with regards to BRM solutions, we identify a predominant emphasis on technical and theoretical application of information technology. This finding concurs with Nelson, Rariden, and Sen (2008), who state: "Studies provide beginnings of a business rules research program, but collectively the research often overlooks major steps in BRM and fails to focus on business rules specific challenges and the larger context that rules play in organizations". Therefore, we identify that the BRM domain does not show a well-balanced mix of research, which several other researchers have also noted (Kovacic, 2004; Nelson, Peterson, Rariden, & Sen, 2010). For instance, Nelson, Peterson, Rariden, and Sen (2010, p 30.) state: "with so much emphasis towards the technological aspects, we can lose sight of the management of information systems considerations". Further, after studying 1,020 papers, Arnott and Pervan (2005) conclude that the field lost its connection with industry some time ago and little research has practical relevance.

Contribution:

Most current BRM solutions research emphasizes technical and theoretical applications of information technology. Literature shows a lack of knowledge regarding practical insights and of an integrated, overall perspective in implementations of this specific type of IS solution. This paper focuses on the implementation of BRM solutions in the Dutch governmental context and indicates that organizations this particular sector experience many challenges in practice. We decided to conduct this study after the Dutch Government formulated goals for improving their e-services by applying several mechanisms, of which implementing BRM constituted one (The Ministry of Economic Affairs and Climate Policy, 2017). From a theoretical perspective, our results build new knowledge on BRM solutions and provide a framework for future research directions. We note that more research needs to examine the organizational implementation of BRM. From a practical perspective, our study provides several challenges that governmental institutions face in designing and implementing a BRM solution, which other organizations could consider in the future to avoid common pitfalls in similar projects, prioritize their resources, and adjust their BRM implementation strategy.

From analyzing 1,466 papers, Arnott and Pervan (2014) conclude that the body of knowledge on BRM has begun to transition toward a more practical-oriented approach but that it still lacks a strong connection between theory and practice (Arnott & Pervan, 2014). Zoet (2014) makes similar conclusions. Thus, we posit that we need BRM research from a broader perspective that considers the application of BRM in practice. Additionally, Nelson, Rariden, and Sen (2008) and Zoet (2014) argue that BRM-related research should focus on the management perspective, which features methods and techniques rather than only focusing on the information technology perspective. Based on these premises provided in literature, we conduct research that adds to the theoretical body of knowledge and focuses on the implementation of BRM solutions in practice. Furthermore, our research features a broad focus given that we consider the whole spectrum of information systems and information technology by applying the information systems framework that Weber (1997) originally proposed and Strong and Volkoff (2010) extended.

Governmental institutions constitute one type of organization that have increasingly begun to implement BRM. Government institutions deliver public administration services that in laws and regulations specify. Based on those laws and regulations, government institutions can only execute business processes and decisions and use data registered to a particular service in restricted ways. Because laws and regulations change constantly (e.g., due to societal developments), the public administration services also need to change. BRM can help organizations design and implement these public administration services. Business rules constitute BRM's key building blocks, which organizations translate from laws and regulations into computer-executable business rules, and serve as building blocks for legal products and/or services. To understand the challenges governmental institutions experience when implementing BRM, we address the following research question (RQ):

RQ: Which implementation challenges do governmental institutions encounter while implementing BRM's elicitation, design, and specification capabilities?

This paper proceeds as follows: in Section 2, we review the BRM problem space. In Section 3, we present the research method we used to identify the current BRM implementation challenges at Dutch governmental institutions. In Section 4, we describe how we collected and analyzed our research data. In Section 5, we present our results and review the challenges in implementing BRM's elicitation, design and specification capabilities. Finally, in Section 6, we discuss the research methods we used and our results, propose possible directions for future research, and conclude the paper.

2 Background and Related Work

With increasing investments in BRM, organizations are searching for ways to better design BRM solutions. A business rule refers to "a statement that defines or constrains some aspect of the business intending to assert business structure or to control the behavior of the business" (Morgan, 2002). A BRM solution enables organizations to elicit, design, specify, verify, validate, deploy, execute, evaluate and govern business rules (see Figure 1) (Graham, 2007; Kovacic, 2004; Nelson et al., 2008; Schlosser, Baghi, Otto, & Oesterle, 2014; Zoet, 2014). When an organization designs a BRM solution, it needs to design, implement, and govern each of the nine mentioned capabilities. The manner in which way an organization realizes the capabilities depends on the organization's actual situation. This paper forms part of a large research project that evaluated all nine capabilities of five Dutch governmental institutions. Earlier studies focus on the verification and validation (Smit, Versendaal, & Zoet, 2017), monitoring (Smit & Zoet, 2016), and governance capabilities (Smit et al., 2017). In this paper, we investigate the elicitation, design, and specification capabilities. By doing so, we focus on the major challenges experienced in practice in implementing these capabilities. Smit and Zoet (2016) explain each capability in detail. However, to ground our research, we summarize the elicitation, design, and specification capabilities below.

The elicitation capability determines the knowledge that the organization needs to capture from various legal sources to realize its value proposition. The different types of legal sources from which one can derive knowledge include: laws, regulations, policies, internal documentation, and human experts. Depending on the type of knowledge source(s) and the current state of a BRM solution, an organization needs different processes, techniques, and tools to extract the knowledge. The knowledge required to design the business rules architecture constitutes the capability's output. If an organization already has a business rules architecture, it conducts an impact analysis. The actual business rules architecture results from the design capability. The business rules architecture comprises a combination of so-called design contexts and derivation structures. A design context refers to business knowledge (in terms of business

rules and fact types) with maximum internal cohesion and minimal external coherence. A derivation structure depicts the relationship between different design contexts. After the organization designs the business rules architecture, it needs to specify the actual contents of each individual design context. The specification capability determines and describes the business rules and creates the fact types needed to define or constrain some particular aspect of the business. The specification capability outputs a specified context that contains business rules and fact types (Zoet, 2014).

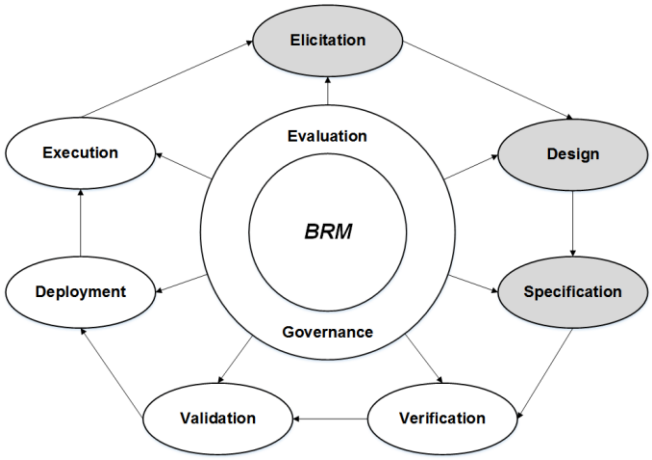

Figure 1. BRM Capabilities Overview

3 Research Method

In this study, we identify challenges that Dutch governmental organizations experienced while implementing BRM's elicitation, design and specification capabilities. The maturity of the BRM research field, with regard to non-technological research, is nascent (Kovacic, 2004; Nelson et al., 2010; Zoet, 2014). In nascent fields, an appropriate focus involves identifying new constructs and establishing relationships between identified constructs (e.g., Edmondson & McManus, 2007). To do so, many researchers use explorative qualitative research methods. Therefore, we conduct a qualitative study, and, through grounded theory-based data collection and analysis, we search for challenges regarding the elicitation, design, and specification capabilities. Furthermore, we selected grounded theory-based data collection since, to our knowledge, no research has used grounded theory to examine the challenges in BRM implementations. Explorative research methods better suit this context because they allow one to develop context-based descriptions and explanations of a phenomenon (Myers, 1997).

For research methods related to exploring a broad range of possible solutions to a complex issue and combining them into one view when a lack of empirical evidence exists, one can use group-based research techniques (Delbecq & Van de Ven, 1971; Okoli & Pawlowski, 2004; Ono & Wedemeyer, 1994). Examples of group-based techniques include focus groups, Delphi studies, brainstorming, and the nominal group technique. The main characteristic that differentiates these types of group-based research techniques from each other is whether they use face-to-face or non-face-to-face approaches. Both approaches have advantages and disadvantages; for example, in face-to-face meetings, interviewers and interviewees can provide immediate feedback. However, face-to-face meetings have restrictions with regard to the number of participants and the possible existence of group or peer pressure. To eliminate the disadvantages, we combined the face-to-face and non-face-to-face techniques by applying the following two group-based research techniques: the focus group and Delphi study. We chose to use a focus group because it allows participants to broadly interact on a topic in a limited amount of time. Compared to participant observation in the form of interviews, when using focus groups, one can compare a substantial set of observations with regards to the topic of interest (Morgan, 1996), which aligns with the limited amount of time we received to interview the participants face to face. Further, we used the Delphi method, as a non-face-to-face technique, so we could include a larger sample size and validate the challenges that we identified with the focus groups (Okoli & Pawlowski, 2004). By applying controlled opinion feedback during the Delphi study, we could gather data on the identified challenges anonymously. This anonymity (between participant and researcher) mitigates peer pressure and allows one to collect data a more natural environment compared to a focus group approach (Morgan, 1996).

To structure our results and findings, we selected the information systems framework that Weber (1997) proposed and Strong and Volkoff (2010) extended. Specifically, we selected this framework due to 1) its general information systems perspective, which we applied to structure and categorize all possible challenges identified; 2) its proven status in the IS/IT community; and 3) its structure because it separates the technical and management perspectives, which means we could confirm whether a particular view dominants the current literature. The framework has four sections: 1) deep structure, 2) organizational structure 3) physical structure, and 4) surface structure. Deep structure elements refer to subjects that describe real-world systems and their properties, states, and transformations (Weber, 1997). Organizational structures refer to the roles, control, and organizational culture represented in organizations or solutions (Strong & Volkoff, 2010). Physical structure elements describe the physical technology and software in which the deep structure is embedded (Weber, 1997). Lastly, surface structure elements describe the available elements in the information system that allow users to interact with the information system (Strong & Volkoff, 2010).

4 Data Collection and Analysis

We collected data for this study over a three-month period (i.e., between January and March, 2014). Data collection and analysis comprised two series of a three-round focus group and a three-round Delphi study (see Figure 2). Since most of the participating organizations combined their design and specification capabilities, we combine the design and specification capabilities and report their results together, which the participants also requested and agreed on.

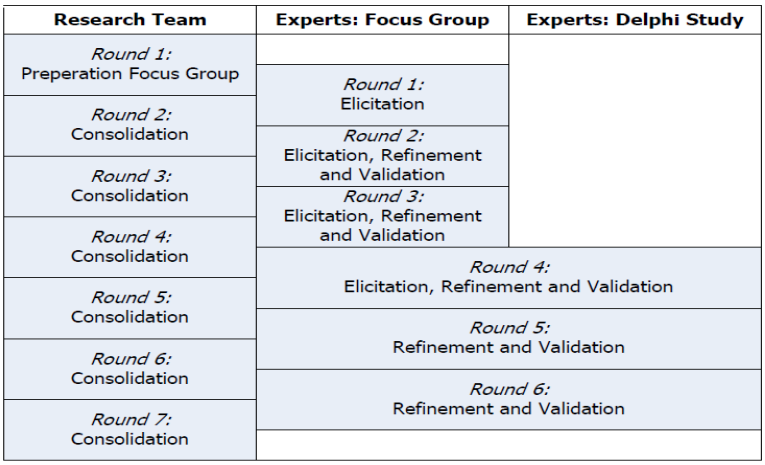

Figure 2. Data-collection Process Design

4.1 Focus Groups

Before one conducts a focus group, one needs to address several topics: 1) its goal, 2) what participants it will include, 3) the number of participants it will include, 4) who will serve as the facilitator, 5) the information-recording facilities, and 6) the focus group's protocol (Morgan, 1996). For this study, we conducted the focus groups to identify the challenges the participants' experienced in implementing BRM's elicitation, design and specification capabilities One should select participants based on the group of individuals, organizations, information technology, or community that best represents the phenomenon under examination (Strauss & Corbin, 1990). In this study, organizations and individuals that deal with a lot of business rules represent the phenomenon studied, such as financial and governmental institutions. Therefore, we invited multiple Dutch governmental institutions to participate in the study. Five organizations agreed to participate: 1) Dutch Tax and Customs Administration, 2) Dutch Immigration and Naturalization Service, 3) Dutch Employee Insurance Agency, 4) Dutch Education Executive Agency, Ministry of Education, Culture and Science, and 5) Dutch Social Security Office. After consulting with each governmental institution and discussing the study's goals with the employees at each one, we selected participants to take part in the three focus group rounds. In total, twelve participants (two business rules architects, three business rule analysts, two policy advisors, three BRM project managers, one tax advisor, and one legislative author) took part in the focus groups regarding the elicitation capability. Moreover, nine participants (one business rules architect, two BRM project managers, and six business

rule analysts) took part in the focus groups regarding the design and specification capabilities. Each of the participants had at least five years of experience with business rules. Delbecq and van de Ven (1971) and Glaser (1978) state that the facilitator should be an expert on the topic and familiar with group meeting processes. The author, who served as the facilitator (second author), has a PhD in BRM, has conducted eight years of research on the topic, and has facilitated many (similar) focus group meetings in the past. In addition to the facilitator, five additional researchers attended the focus group meetings. One researcher participated as a "back-up" facilitator who monitored whether each participant provided equal input and, if necessary, involved specific participants by asking them to elaborate on the subject. The remaining four researchers acted as secretaries. We audio and video recorded all focus groups. On average, the focus groups lasted three hours each. Each focus group meeting followed the same protocol: they started with an introduction and explanation of the purpose and procedures of the meeting. After the introduction, the participants generated, shared, discuss, and refined ideas.

Prior to the first round, we informed participants about the purpose of the focus group meeting. Furthermore, we invited them to submit secondary data about the challenges they faced while implementing BRM's elicitation, design, and specification capabilities. When participants had submitted their secondary data, they had the opportunity to elaborate on their documented challenges during the first focus group meeting. During this meeting, they also presented and discuss challenges that the secondary data did not include. For each addressed challenge, we noted the name, description, origin (regarding which institutions experienced the same or similar challenges), and classification. After the first focus group, we analyzed and consolidated the results.

We sent the results to the participants of the focus group two weeks in advance for the second focus group meeting. During these two weeks, the participants assessed the consolidated results in relationship to three questions: 1) "Are all challenges described correctly?", 2) "Do we need to address additional challenges?", and 3) "How do the challenges affect the design and/or implementation of the BRM capability?". We repeated this process (i.e., conducted a group meeting, consolidated the findings, and sent them to the participants) again one final time after the second. After the third focus group meeting (third round), we reached theoretical saturation. As a result, we created an overview of the challenges that the organizations faced while implementing BRM's elicitation, design, and specification capabilities.

We analyzed the data in three coding cycles following Strauss and Corbin's (1990) process of 1) open coding, 2) axial coding, and 3) selective coding. After each focus group round, we conducted open coding, which involved our analyzing significant participant quotes. In this process, we tried to identify what Boyatzis (1998) refers to as "codable observations". Here, we coded the data by identifying sentences that discussed challenges. The participants named and listed challenges that occurred. For example, one of the codable observations was: "We design and specify our contexts and business rules in Microsoft Word, which forced us to define guidelines as we usually work with five or more people on the same business case. However, these guidelines are not enforced by Microsoft Word.".

Subsequently, we conducted axial coding during the analysis and consolidation phase between the focus group rounds to see what challenges we could identify and how the participants supported their challenges. We employed Toulmin's (2003) framework, which comprises three elements (i.e., claim, ground, and warrant), to code the challenges addressed in the focus group rounds. For example, we coded the following claim-ground-warrant relationship: claim: "working with the tools we currently use is amateurish"; ground: "[working with MS word] which forced us to define guidelines as we usually work with five or more people on the same business case. However, these guidelines are not enforced by Microsoft Word", and warrant: "authority, the reliability and validity originated from a presumed expert source".

Lastly, we conducted selective coding to categorize the identified challenges that the axial coding process produced. We adhered to the coding family "unit" during the selective coding rounds (Glaser, 1978) to categorize the identified challenges. This process required inductive and deductive reasoning. We applied inductive reasoning to reason from concrete factors to general situational factors. For example, two participants reported using Microsoft Word to specify and manage business rules, while four other participants reported using Microsoft Excel to specify and manage their business rules. In this case, we coded both statements to the maturity of tooling to support the design and specification capabilities. We applied deductive to reason from general situational factors to specific cases. For example, one participant stated that the language they applied to formulate business rules was not sufficient enough. When the facilitator asked the participant to elaborate on this topic more, the participant noted that the business rules language the participant applied was not precise enough. Therefore, we assigned the challenge to the precision of the business rules language.

4.2 Delphi Study

Before one conducts a Delphi study, one needs to address several topics: 1) its, 2) what participants it will include, 3) the number of participants it will include, and 4) its protocol (Okoli & Pawlowski, 2004). We conducted the Delphi study to: 1) validate and refine the challenges identified in the focus group meetings and 2) identify additional challenges. After consulting with each governmental institution and discussing the study's goals with the employees at each one, we selected participants to take part in the Delphi study. In total, 44 participants (21 experts from the focus groups and 23 new ones) participated in the Delphi study. We included the 21 experts from the focus groups in the Delphi study to decrease the effects that peer pressure may have had on the experts in the focus groups and, thus, our findings. Delphi studies reduce peer pressure because they feature a non-face-to-face approach (in this study, an online questionnaire that the participants had to return via email). The additional 23 participants involved in the Delphi study had the following positions: one software engineer, one project manager, four enterprise architects, three business rules analysts, four policy advisors, two IT architects, three business rules architects, two business consultants, one functional designer, one legal advisor, and one knowledge management expert. Each of the 23 additional participants had at least two years of experience with business rules. Each round (fourth, fifth, and sixth) of the Delphi Study followed the same protocol whereby we asked each participant to assess the identified challenges in relationship to three questions: 1) "Are all challenges described correctly?", 2) "Do we need to address additional challenges?", and 3) "How do the challenges affect the design and/or implementation of a BRM solution?. To analyze the data we collected from the Delphi study rounds, we adhered to the same coding method as we describe in Section 4.1.

5 Results

In this section, we summarize the challenges obtained from analyzing our data. The order we present the challenges in do not reflect their relative importance. Since we focused solely on identifying the challenges that organizations face in identifying the capabilities to elicit, design, and specify business rules, we did not explore solutions to the challenges we identified.

First, we overview the identified challenges in Figure 3. In this figure, we map the challenges alongside Weber's (1997) and Strong and Volkoff's (2010) information systems framework. In Section 5.1, we describe the general implementation challenges that apply to all capabilities and, in Section 5.2, the specific challenges per capability.

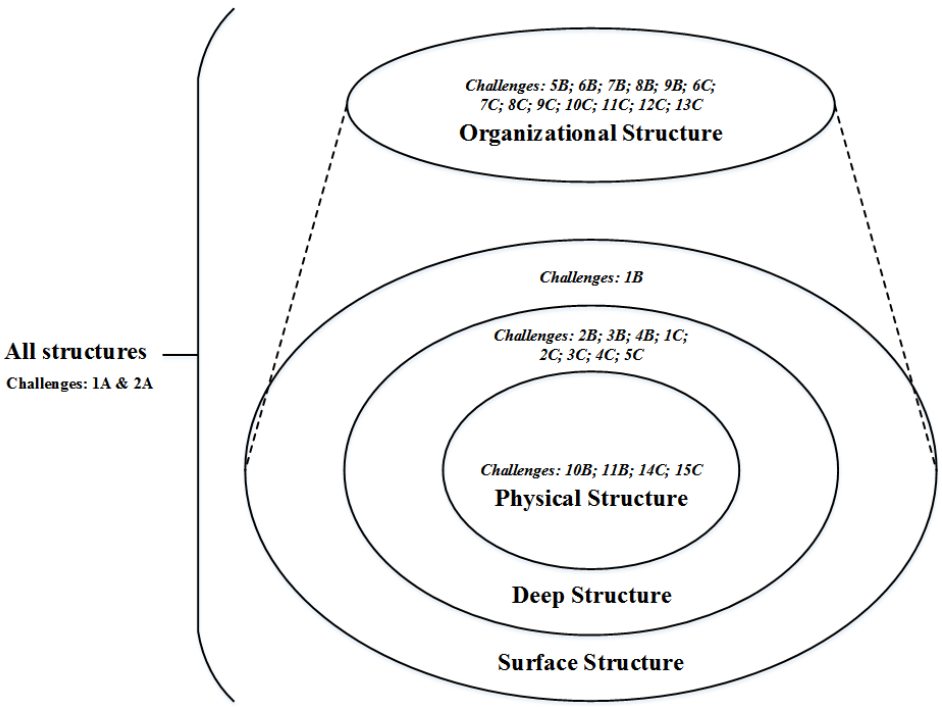

Figure 3. Mapping of Identified Challenges: An Overview

5.1 General Implementation Challenges

The first general implementation challenge (1A) concerns the lack of structured and repeatable processes for each BRM capability. The participants stated that their organizations performed activities on an ad hoc basis and, thus, that they could not predict the quality of their output because current BRM practices mostly focus on implementing software systems and not on the needed business processes.

The second general implementation challenge (2A) concerns employees' education and knowledge level with respect to BRM. All participants indicated that their organizations had challenges with recruiting employees who had subject-matter knowledge, methodological knowledge, and technological knowledge with respect to BRM's elicitation, design, and specification capabilities. Additionally, the participants addressed that new employees required significant costs in organizational resources to educate so that their organizations could use them in the BRM processes.

5.2 Elicitation Implementation Challenges

5.2.1 Surface Layer Implementation Challenges

Challenge 1B: inadequate available languages that help one efficiently and effectively annotate business rules. Indeed, laws and regulations use natural language and, therefore, are imprecise and ambiguous; thus, one cannot easily translate them into business rules, and different individuals may understand them in different ways. One of the participants stated:

> *Rule-speak contains too much specification freedom, that's why we started to design our own language, Regelspraak, which does not allow for different interpretations as we work with a set of patterns in which the laws and regulations must be captured.*

5.2.2 Deep Layer Implementation Challenges

Challenge 2B: products and services do not align well with laws and regulations. Indeed, laws and regulations do not have a structure that agrees with the products and services that governmental institutions deliver. For example, to design and specify the service "grant benefits", one must elicit business rules from multiple different laws and regulations. The meta-models that the organizations applied to describe both laws and products did not align adequately with each other and, thus, featured major differences. One of the participants stated:

> *Laws and regulations are, on the higher abstraction level, easy to understand and thus to model. However, when modeling the details of lower abstraction levels of law, many exceptions exist, and even then, there are exceptions regarding these exceptions. To make it even worse, different groups are defined within those exceptions.*

Another participant added: "All forms of standardization used to align the law with the execution are not taken into account in these exceptions, and there are a lot of them.".

Challenge 3B: inability to effectively connect fact types with database entities in existing databases. Ideally, when an organization deploys business rules, it should directly connect the fact types used in those business rules to database entities in an existing database. However, the participating organizations could not directly connect fact types with their corresponding database entities due to a meta-model design that did not consider the relationship between a fact type and a database entity. As a result, the participating organizations all needed to perform additional manual activities to ensure that they connected the fact types, as part of deployed business rules, with database entities in order to execute them.

Challenge 4B: limited knowledge on specifying business rules for synthetic task types. The organizations' projects focused on one specific type of task (i.e., only analytic-type decisions) (Breuker & Van de Velde, 1994). Further, the organizations contained only knowledge on business rules to specify analytic tasks. Therefore, they could not specify business rules that guide synthetic tasks.

5.2.3 Organizational Layer Implementation Challenges

Challenge 5B: inadequate collaboration with third party staff. All the participants indicated that they experience the large numner of external staff in their organizations as a burden. Sometimes, external staff elicited, designed, and specified all business rules. For example, one of the participants stated: "If we

could go back in time I would ensure that people of our own organization participated in the definition of the elicitation, design, and specification processes as these are all fully defined by external employees." Collaboration is a challenge because 1) external staff can more easily leave the organization because contracts typically do not bind them and work per hour and 2) all participants experienced difficulties with external staff in documenting their accumulated knowledge even when asked to do so.

Challenge 6B: inadequate collaboration with ministries that provide law and regulations that need to be implemented. The participants addressed that they needed to extensively collaborate with ministries to further improve their BRM processes. However, the ministries did not adequately consider the practical aspects of executing and enforcing new or changed laws and regulations, but the organizations needed to do so to ensure they produced the desired societal effects. A participant stated: "Five years ago we did not dare to say we could not execute the proposed changes by legislative institutions. This has changed a bit, but we still find it hard to do.". The gap in perspective between both the ministries and executive government institutions led to frustration and decreased efficiency.

Challenge 7B: inadequately governed fact vocabularies. The participants indicated that an organization requires a fact vocabulary in implementing laws and regulations because it allows the organization to centrally manage all fact types that business rules for different products and services use. However, the participants also indicated that their organizations did not adequately enforce the process of maintaining the fact type vocabulary, which resulted in an increase in errors while eliciting, designing, and specifying services and their business rules.

Challenge 8B: the elicitation of legal requirements does not cover all scenarios. The organizations used three elicitation methods to develop public administration services: a top-down approach, a scenario-based approach, and a hybrid form of both. When adhering to a top-down approach, one designs the services while considering the relevant laws and regulations. However, a bottom-up approach (also called scenario-based elicitation) enables organizations to work from possible customer scenarios. Three of the five participating organizations used the top-down approach. However, the participants indicated that the bottom-up approach covered all customer scenarios, while the top-down approach could result in unsupported scenarios. Nonetheless, the participants stated that the scenario-based approach consumed more resources and, therefore, that they often had to use the top-down approach instead.

Challenge 9B: elicitation's inadequate output quality. All participants experienced time pressure in the elicitation processes due to two reasons: 1) politics that caused shifting deadlines and 2) a government institution must execute a feasibility study to examine to what extend new or changing laws and regulations it can effectively and efficiently execute in practice. To make sure that it meets both demands, it spends less time on the elicitation process, which results in a reduced fault-proof elicitation of legal requirements from legal sources. For example, one of the participants stated: "Time pressure is playing an increasingly important role, therefore we sometimes are forced to only analyze on a high-level abstraction for potential impact. Available time determines the quality of the analysis.". Low-quality elicitation output can pose organizations with risks due to the fact that, as a consequence of inadequate elicitation of legal requirements, they inadequately design and execute laws and regulations.

5.2.4 Physical Layer Implementation Challenges

Challenge 10B: inadequate supportive tooling. Indeed, existing support tools do not support the following activities: automatically importing laws and regulations, annotating laws and regulations, and conducting impact analyses. Two different participants stated:

> *All activities to determine what legal requirements affect the current implementation are performed manually (i.e., letters, education material, work instructions, translations, IT codes). This is terrible to do manually and a lot of work.*
>
> *Individuals all have different areas of expertise and they all individually check for the impact that proposed changes to a law result into. However, what happens with continuity of the analysis when such experts suddenly are unable to do their job (e.g., due to accident, disease, or death).*

Based on negative experiences with commercial tooling, three case organizations started developing their own annotation tool to support the elicitation process.

Challenge 11B: tooling does not or inadequately supports traceability of legal requirements to business rules and other software-related building blocks. Indeed, a government service that uses business rules involves a large amount of different legal sources. According to the participants, insufficient traceability

leads to an unwanted amount of manual activities when eliciting legal requirements from legal sources because it makes it harder to identify modifications between versions and impacts existing implementations of the operational service. For example, one participant stated:

> *Simulations for impact are performed manually—in my head. However, all the information I need to know to be able to do so needs to be manually requested by specific colleagues, for example, how much time or money does it cost to change letters per impacted user group, or how much time does it take to change certain codes in a system*.

5.3 Design and Specification Implementation Challenges

5.3.1 Deep Layer Implementation Challenges

Challenge 1C: inadequate precision and expressiveness of languages to design and specify business rules. Indeed, the languages that the participants used were not expressive and precise enough to design contexts and business rules in their design and specification processes. Also, the participants experienced that software suppliers had this problem and that these languages could benefit from further user-driven development so that they could formalize all legal requirements in business rules.

Challenge 2C: inadequate structuring or grouping business rules when using the available languages. Indeed, the modeling languages that the participated organizations used did not support an element to group and structure business rules because most languages focus on business rules (e.g., RuleSpeak, declarative process modeling notation (DMPN), and semantics of business vocabulary and rules (SBVR)), which results in a big bucket of business rules that one cannot relate to each other with separate elements to apply cohesion. One of the participants stated: “We use MS PowerPoint to structure groups of rules from our rule base as the current language does not structuring of rules adequately.”.

Challenge 3C: inadequate quality of the quality criteria for designing and specifying BRM artefacts. Indeed, the organizations often did not have any quality criteria, or, when they had some in place, they did not validate them adequately and applied them in an ad hoc manner. As a result, the organizations designed and specified products with an unpredictable quality. For example, business rules not specified according to the quality criteria but submitted to the verification process could result in an unnecessary waste of organizational resources. Such a situation can occur when an organization detects quality challenges in the verification and validation processes, which triggers the organization to redesign the product. Similarly to general software artifact development, adjustments to BRM-related artifacts consume more resources when processed later on in their development process (The Standish Group, 2014).

Challenge 4C: not considering the method in which data stakeholders or end users provide data. The participants noted that their design and specification processes did not consider the data-input method for the applied business rules. For example, one organization had a business rule that ran over several pages to determine whether a vehicle was a recreational vehicle. However, this business rule set contained measurements that citizens could not collect themselves. Therefore, the organization translated the business rule into a Boolean question: “Is the vehicle a recreational vehicle?”. This example demonstrates that the data-collection method influences the specification processes. Not determining upfront how to collect data leads to situations where business rule analysts over- or under-specify derivation structures and business rules and, thus, to incorrectly allocated resources.

Challenge 5C: insufficiently maintainable and extensible meta-models. The participants stated that, due to time pressures, they paid insufficient attention on creating a maintainable and extensible meta-model, which caused problems when the government introduced additional laws and regulations or when it changed existing ones. The participants urged that, if they could change one thing in a BRM project, they would spend more time on designing maintenance-proof meta-models. For example, the participants learned that they could separate elements from each other (also called the “single responsibility principle) so that they could be modified and managed separately. However, their organizations’ meta-models did not allow for such a change to the structure because it would have impacted their existing products and services too much.

5.3.2 Organizational Layer Implementation Challenges

Challenge 6C: inadequate activities and processes to specify implementation independent BRM artefacts. Some participants indicated that their organizations did not have a process that structured the activities required to design and specify contexts and business rules in their implementation-independent

form. They indicated that they needed such a process due to the fact that large organizations that deal with business rules often use a wide variety of software systems that all have their own language that refer to business rules as implementation-dependent business rules. Using implementation-independent business rules can benefit an organization because it needs to design and specify them in a uniform way. As such, they constitute a central point of truth for further transformation and implementation into specific software systems. One participant stated:

> *The process to design contexts and business rules is important, but we don't have a process to do so. When we had a team meeting we said to each other: just get started with designing and specifying. However, we did this without any guidelines or process*.

Challenge 7C: inadequate collaboration with third party staff. Similar to the reported challenges regarding the elicitation capability, participants stated that many external staff members worked on the design and specification processes and that this dependence posed the participating organizations with various risks. For a detailed explanation, see challenge 5B.

Challenge 8C: inadequate communication with IT departments regarding the specification of business rules. Participants noted that, on the operational level, teams responsible for the specification of business rules had many discussions with IT departments about how the organizations specified business rules. The communication gap between both can also be referred to as the "gray zone" in laws and regulations versus "black and white" that needs to be implemented into computer systems. The participants did not consider these discussions as that problematic. However, they can slow down the implementation process of business rules and, thus, decrease productivity of the organization as a whole. The participants indicated that either colleagues of the IT department should join the business rules designers in this particular process and directly influence the design of business rules by providing requirements from an IT perspective or that such discussions should occur in the validation process(es).

Challenge 9C: inadequately considering knowledge loss. The participants indicated that a handful of people convened the BRM processes, which can lead to problems in BRM processes when internal staff that specialized in, for example, a specific jurisdiction leave the organization. Further, the participants argued that the organizations did not adequately document the accumulated knowledge, which resulted in a loss of knowledge and possibly influenced BRM processes in terms of efficiency and effectiveness. Lower effectiveness in the design and specification processes possibly result in noncompliance, and, thus, organizations should focus on mitigating it.

Challenge 10C: inadequately considering the five Vs (dimensions) during design and specification. The participants found it difficult to determine the trade-off between five dimensions in design and specification processes: 1) volume, 2) velocity, 3) veracity, 4) variance, and 5) value. Although the names of the five Vs resemble the five Vs applied in big data (Kaisler, Armour, Espinosa, & Money, 2013), they differ in meaning:

1) Volume stands for the number of decisions made in a specific time unit.
2) Velocity stands for the amount of time in which a decision must be taken.
3) Veracity stands for the quality of the decision (i.e., whether the decision needs to be 100% accurate or whether 70% is enough; the recommender systems on retail websites exemplify the latter).
4) Variance indicates the variance in the decision made based on two main variables: the a priori definition of the possible execution paths and the change rate of the execution paths. For example, in diagnosing patients, doctors have many execution paths they cannot define a priori. On the other hand, one can easily determine whether a specific case falls under the "data-protection law", which means one can define each path a priori. The second variable comprises the change rate of the possible execution paths (e.g., whether the "data protection law" change every minute, month, six months, etc.).
5) Value indicates the decision's importance for the organization (e.g., whether inadequately executing a decision costs the organization one dollar, ten dollars, or thousands or millions of dollars).

Based on the trade-off for each V, an organization can decide to fully elicit, design, and specify the business rules or to not specify the business rules. For example, the cost to fully specify a decision that occurs once a year and that one must do within six months may be higher than consulting an subject matter expert once a year. The organizations wasted precious resources designing and specifying

business rules because they did not use the five Vs that we describe earlier. Doing so enables one to properly assess a product's or service's cost/benefits. Additionally, the participants stated that they considered some of the Vs but later on (e.g., during the design or specification of the business rules), which could result in their ceasing to develop business rules after they had already executed the elicitation and design processes. The participants found it desirable to consider these five Vs before the elicitation processes began.

Challenge 11C: non-existent or inadequate change management. The participants indicated that the organizations had no change-management processes in place or that the ones they did have were decentralized. All participating organizations except one employed decentralized change processes regarding decisions, business rules, fact types, and fact values. Participants indicated that this particular approach hampers maintainability in general as, for example, changes to fact types usually also affect the business rules that use them. Therefore, the decentralized processing of changes does not consider relations between elements in the design and specification processes that cause ripple effects. Moreover, because different departments or teams can simultaneously initiate modifications to the same elements, modified elements could come into conflict with each other.

Challenge 12C: inadequate knowledge of business rule architectures. The participants noted that they had insufficient processes, guidelines, and best practices to create the business rule architectures to ensure the many business rules in their organizations cohered with each other. When subject matter experts individually create parts of business rules architectures, the combined total business rules architecture is not coherent, which results in unnecessary work afterward.

Challenge 13C: a lack of processes to create business rules architectures. The organizations did not have a process to create business rules architectures, which resulted in an output with an unpredictable quality. The participants stated that the quality and procedure depends on the knowledge level of the individual employee who creates the business rules architecture. Moreover, employees conducted the activities to create a business rules architecture in an ad hoc manner. The participants indicated that they would welcome a standardized process to create business rules architectures. For example, one participant stated: "When a method to create business rules architectures is utilized and adhered to by all the employees that structure the business rules I think that the quality of the outcome will be more stable."

5.3.3 Physical Layer Implementation Challenges

Challenge 14C: inadequate maturity of supportive tooling. Almost all participants used regular spreadsheet software to design, specify, and maintain their contexts and business rules, which resulted in a decreased effectiveness and efficiency in these processes. The participants required tools that satisfied the requirements of experts who design, specify, and maintain contexts and business rules. One participant said:

> *Working with the tools we currently utilize is amateurish*" and "*We design and specify our contexts and business rules in Microsoft Word, which forced us to define guidelines as we usually work with five or more people on the same business case. However, these guidelines are not enforced by Microsoft Word.*

Challenge 15C: not considering data availability when designing and specifying business rules. The participants argued that the design of business rules depends on the availability of data. For example, a business rule could use the age of a patient as one of the conditions to derive a conclusion if it had the patient's birth date rather than the patient's age. In this case, one must specify an extra business rule to derive the age using the birth date. The organizations did not adequately consider data availability when designing and specifying business rules. Such errors are often identified during the verification and validation processes later on in the business rule lifecycle, which means that the organizations may later need to redesign the business rules. Such redesigns lead to unwanted waste of precious resources.

6 Discussion and Conclusion

In this paper, we examine the following research question: "Which implementation challenges do governmental institutions encounter while implementing BRM's elicitation, design, and specification capabilities?". To do so, we conducted a study that combined two series of focus groups with three rounds each and two series of Delphi studies with three rounds each. In total, 44 participants participated in the study. After collecting and analyzing our data, we identified 28 main implementation challenges that

organizations should consider when designing a BRM solution. When analyzing the challenges closely, we see that we mapped most challenges to either the deep or organizational layer. From analyzing the deep layer challenges, we found that organizations can use many languages to represent business rules. However, the challenges in the deep layer illustrate that there is little integration possible between the available languages and that the organizations strongly desired a generic language that can support different meta-models from different organizational contexts. We can see a solution in the recently published decision model and notation standard (Object Management Group, 2015), which focuses on uniformity and portability of decisions and business rules. Further, one can see that we identified many organizational challenges and few technical and surface challenges, which concurs with Arnott and Pervan's (2005) and Nelson et al.'s (2008, 2010) findings that the technological and the managerial research streams regarding BRM have different maturity levels (i.e., relatively mature for the technological but nascent for the managerial).

From a theoretical perspective, we map our results to Weber's (1997) and Strong and Volkoff's (2010) information systems framework (see Figure 3). The insights we derive better explain the challenges that organizations experience with BRM in the context of the information systems framework and enable researchers to further explore and identify problem classes. Furthermore, our results emphasize the conclusions drawn from earlier literature with regards to the technical versus organizational maturity of BRM implementation. From a practical perspective, our study provides challenges in designing and implementing a BRM solution at governmental institutions, which future organizations that wish to avoid common pitfalls in future projects should consider. The organizations we analyzed have begun to implement practices to mitigate the challenges we identified. Furthermore, based on our results, clients and software vendors can themselves develop best practices, concepts, and methods

Our study has several limitations one should consider. The first limitation concerns the sampling and sample size. We used participants solely from governmental institutions in the Netherlands. While we believe that government institutions represent all organizations that implement BRM solutions, we need more research to generalize our findings towards non-governmental and other organizations. Additionally, future research should validate our results in governmental contexts other than in the Netherlands (i.e. other countries). With regards to research in this direction, one should probably consider the effect of cultural diversity due to the fact that governmental institutions in, for example, North America or Asia apply different design solutions and, therefore, could experience different challenges with regards to implementing BRM solutions. Future research could also increase the sample size we used (i.e., 44 participants). Examining our results in Figure 3, we can identify an overrepresentation of deep and especially organizational-related challenges. Other studies have also identified this phenomenon (Arnott & Pervan, 2005; Arnott & Pervan, 2014; Boyer & Mili, 2011; Nelson et al., 2008) since most research has focused on the technical perspective. Therefore, future research should also investigate whether this phenomenon relates to our data collection and analysis.

In this study, we focus on identifying new constructs and establishing relationships. Although we used an appropriate research approach, research that focuses on further generalization should apply other research methods, such as quantitative research methods, to incorporate larger sample sizes to further validate our findings. Yet, given BRM research's nascence, doing so might be more appropriate in the years to come.

References

Arnott, D., & Pervan, G. (2005). A critical analysis of decision support systems research. *Journal of Information Technology*, *20*(2), 67-87.

Arnott, D., & Pervan, G. (2014). A critical analysis of decision support systems research revisited: the rise of design science. *Journal of Information Technology*, *29*(4), 269-293.

Bandara, W., Indulska, M., Chong, S., & Sadiq, S. (2007). Major issues in business process management: An expert perspective. In *Proceedings of the European Conference on Information Systems* (pp. 1240-1251).

Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. Thousand Oaks, CA: Sage.

Boyer, J., & Mili, H. (2011). *Agile business rule development: Process, architecture and JRules examples.* Berlin: Springer.

Breuker, J., & Van de Velde, W. (1994). *CommonKADS library for expertise modelling: Reusable problem solving components* (21st ed.). Amsterdam: IOS press.

The Ministry of Economic Affairs and Climate Policy. (2017). *Reduction of rule pressure*. Retrieved from https://www.rijksoverheid.nl/documenten/rapporten/2017/05/12/goed-geregeld-een-verantwoorde-vermindering-van-regeldruk-2012-2017

Delbecq, A. L., & Van de Ven, A. H. (1971). A group process model for problem identification and program planning. *The Journal of Applied Behavioral Science*, *7*(4), 466-492.

Eikebrokk, T. R., Iden, J., Olsen, D. H., & Opdahl, A. L. (2011). Understanding the determinants of business process modelling in organisations. *Business Process Management Journal*, *17*(4), 639-662.

Glaser, B. G. (1978). *Theoretical sensitivity: Advances in the methodology of grounded theory*. Mill Valley, CA: Sociology Press.

Gottesdiener, E. (1997). Business rules show power, promise. *Application Development Trends*, *4*(3), 36-42.

Graham, I. (2007). *Business rules management and service oriented architecture: A pattern language*. New York, NY: John Wiley & sons.

Indulska, M., Chong, S., Bandara, W., Sadiq, S., & Rosemann, M. (2006). Major challenges in business process management: An Australian perspective. In *Proceedings of the Australasia Conference on Information Systems.*

Jeston, J., & Nelis, J. (2014). *Business process management*. New York, NY: Routledge.

Kaisler, S., Armour, F., Espinosa, J. A., & Money, W. (2013). Big data: Challenges and challenges moving forward. In *Proceedings of the Hawaii International Conference on System Sciences* (pp. 995-1004).

Kovacic, A. (2004). Business renovation: Business rules (still) the missing link. *Business Process Management Journal*, *10*(2), 158-170.

Lönn, C. M., & Uppström, E. (2013). Process management challenges in Swedish public sector: A bottom up initiative. In *Proceedings of the International Conference on Electronic Government* (pp. 212-223).

Morgan, D. L. (1996). *Focus groups as qualitative research* (16th ed.). Thousand Oaks, CA: Sage.

Morgan, T. (2002). *Business rules and information systems: Aligning IT with business goals*. Boston, MA: Addison-Wesley.

Myers, M. D. (1997). Qualitative research in information systems. *MIS Quarterly*, *21*(2), 241-242.

Nelson, M. L., Peterson, J., Rariden, R. L., & Sen, R. (2010). Transitioning to a business rule management service model: Case studies from the property and casualty insurance industry. *Information & Management*, *47*(1), 30-41.

Nelson, M. L., Rariden, R. L., & Sen, R. (2008). A lifecycle approach towards business rules management. In *Proceedings of the Annual Hawaii International Conference on System Sciences* (pp. 113-123). IEEE.

Object Management Group. (2015). *Decision model and notation* (ver. 1.0). Retrieved from http://www.omg.org/spec/DMN/1.0/

Okoli, C., & Pawlowski, S. D. (2004). The Delphi method as a research tool: An example, design considerations and applications. *Information & Management*, *42*(1), 15-29.

Ono, R., & Wedemeyer, D. J. (1994). Assessing the validity of the Delphi technique. *Futures*, *26*(3), 289-304.

Sadiq, S., Governatori, G., & Namiri, K. (2007). Modeling control objectives for business process compliance. In G. Alonso, P. Dadam, & M. Rosemann (Eds.), *Business process management* (LNCS vol. 4714, pp. 149-164). Berlin: Springer.

Schlosser, S., Baghi, E., Otto, B., & Oesterle, H. (2014). Toward a functional reference model for business rules management. In *Proceedings of the Hawaii International Conference on System Sciences* (pp. 3837-3846).

Smit, K., Versendaal, J., & Zoet, M. (2017). Identifying challenges in BRM implementations regarding the verification and validation capabilities at governmental institutions. In *Proceedings of the Pacific Asia Conference on Information Systems.*

Smit, K., & Zoet, M. (2016). Management control system for business rules management. *International Journal on Advances in Systems and Measurements*, *9*(3-4), 210-219.

Strauss, A., & Corbin, J. M. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Thousand Oaks, CA: Sage.

Strong, D., & Volkoff, O. (2010). Understanding organization-enterprise system fit: A path to theorizing the information technology artifact. *MIS Quarterly*, *34*(4), 731-756.

The Standish Group International. (2014). *Big bang boom*. Retrieved from https://www.standishgroup.com/sample_research_files/BigBangBoom.pdf

Toulmin, S. E. (2003). *The uses of argument*. Cambridge, UK: Cambridge University Press.

van der Aalst, W. M. P. (1998). Three good reasons for using a Petri-net-based workflow management system. In T. Wakayama, S. Kannapan, C. M. Khoong, S. Navathe, & J. Yates (Eds*.), Information and process integration in enterprises: Rethinking documents* (pp. 161-182). Berlin: Springer.

van der Aalst, W. M. P., ter Hofstede, A. H. M., & Weske, M. (2003). Business process management: A survey. In W. M. P. van der Aalst & M. Weske (Eds.), *Business process management* (pp. 1-12). Berlin: Springer.

Vom Brocke, J., Schmiedel, T., Recker, J., Trkman, P., Mertens, W., & Viaene, S. (2014). Ten principles of good business process management. *Business Process Management Journal*, *20*(4), 530-548.

Weber, R. (1997). *Ontological foundations of information systems*. Melbourne, VIC: Coopers and Lybrand and the Accounting Association of Australia and New Zealand.

Zoet, M. (2014). *Methods and concepts for business rules management* (1st ed.). Utrecht: Hogeschool Utrecht.

About the Authors

Koen Smit is a research associate, lecturer and PhD candidate in Business Rules Management at the research chair Digital Smart Services, HU University of Applied Sciences, Utrecht. He holds an MSc in Business Informatics from Utrecht University. Most of his work centers around Business Rules Management, Decision Management, Decision Support Systems and Enterprise Architecture, in which he also reviews related work for several AIS conferences. Since 2014, he works closely with several Dutch governmental institutions, conducting research on the efficiency and effectiveness of BRM implementations.

Martijn Zoet is a professor in business rules management at the research centre for optimizing knowledge-intensive business process, faculty of commercial and financial management at the Zuyd University of Applied Science. He holds a PhD in Business Rules Management from Utrecht University. His research interests are in the areas of business rules management, decision management, decision mining, business rule mining, data analytics, and Fintech. Furthermore, he has fulfilled the role of reviewer for numerous journals and conferences.

Johan Versendaal is Full Professor at the Research Centre Learning & Innovation of HU University of Applied Sciences, Utrecht, with an Endowed Professorship at the Open University of the Netherlands. His research interests include Digitalization, Digital Transformation, and Smart Cities. He holds an MSc and a PhD in Computer Science from Delft University of Technology. He continues to author scientific and business contributions, and takes part in program and organizing committees of IS-related conferences. He supervises several PhD candidates and works together with industry in research projects, having worked for many years in industry, among others, at a global Enterprise Systems vendor.

JOURNAL OF INFORMATION TECHNOLOGY THEORY AND APPLICATION

JITTA is a Publication of the Association for Information Systems
ISSN: 1532-3416