BUSINESS RULES MANAGEMENT PRINCIPLES IN THE DUTCH GOVERNMENTAL CONTEXT

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Abstract

Since more and more business rules management solutions are utilized, organizations search for guidance to design such solutions. Principles are often applied to guide the design of information systems in general. Scientific research on principles for business rules management is limited. The purpose of this paper is to specify, classify, and validate design principles that can be applied to guide the design of a business rules management solution. We conducted a three round focus group and three round Delphi Study, which led to the identification of 22 principles. These 22 principles can be clustered into four categories: 1) deep structure principles, 2) physical structure principles, 3) surface structure principles, and 4) organizational structure principles. Our results provide a framework for the design and analysis of business rules management solutions.

Keywords: Business Rules, Business Rules Management, Principles

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. Both management disciplines are growing closer to each other and in more and more projects are treated as a whole (Gottesdiener, 1997; Zoet et al., 2011). This trend can be explained due to the fact that a proper implementation of BPM and BRM may result in considerable rewards for organizations, building compliance into the fabric of the organization while realizing flexibility to change.

Business processes rely heavily on business rules to express decisions applied to classify, assess, diagnose, monitor and predict (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 behaviour of the business.*" To increase grip on business rules, organizations search for a systematic and controlled approach to support the elicitation, design, specification, verification, validation, deployment, execution, governance, and evaluation of business rules. Such an approach is defined as business rules management (BRM), which is the combination of methods, techniques, and tools (Boyer and Mili, 2011; Ross, 2003, Morgan, 2002; Zoet, 2014).

Now more and more BRM solutions are introduced, organizations are searching for guidance to design such solutions. In multiple disciplines, such as industrial engineering, chemical engineering, civil engineering, electrical engineering, and system engineering an important mechanism to guide the design of products and/or information systems are principles (Greefhorst and Proper, 2011). A principle is a simple, direct statement of an organization's belief about how they want to use a specific system (The Open Group, 2009). In our context, principles are therefore statements of an organization's basic beliefs about how the organization wants to apply BRM and design BRM solutions.

In literature, many different types of principles are recognized: business process management principles, enterprise architecture principles, information technology principles, software design principles, data principles, software architecture principles, application principles, organization principles, and business principles. Each of these sets of principles are design principles to guide the design of a specific part of the organization and reduce the degree of freedom to create a specific solution. Therefore, these principles cannot be dealt with separately but must be considered as a network (Stelzer, 2009). Since BRM is becoming more and more important we propose it should be part of this network. However, research which focuses on principles for BRM is scarce. This article, therefore, extends the understanding of principles with regard to BRM solutions. The specific research question addressed in this paper is: *"Which principles are useful to guide the design of a business rules management solution?"*

The remainder of this paper is organized as follows: first, we provide insights into design solutions, BRM, and principles. This is followed by a description of the research method used to construct our artefact. Furthermore, the collection and analysis of our research results is described. Subsequently, our results which led to our Principles for BRM are presented. Lastly, we discuss upon the contributions and limitations on our study and its outcomes which is followed by a final conclusion.

2   BACKGROUND AND RELATED WORK

Based on a design science research approach, Greefhorst and Proper (2011) propose eight steps to define principles: 1) determine drivers, 2) determine principles, 3) specify principles, 4) classify principles, 5) validate and accept principles, 6) apply principles, 7) manage compliance, and 8) handle changes. The first step 'determine drivers' comprises collecting drivers to serve as starting point to define the principles. Drivers that serve as input for the definition of principles can be risks, goals, objectives,

values, issues, potential rewards and constraints. However, many drivers are not explicitly documented, so they have to be collected from stakeholders. After the relevant drivers have been collected they are translated into candidate principles, during the second step 'determine principles'. This step exists out of three phases. First, candidate principles are derived from drivers, domain knowledge and existing principles. After which this list is filtered and the relevant principles are selected. Each relevant principle is further generalized or specified to the right level of abstraction. During the third step 'specify principles' the principles are further detailed. This means that the rationale, implications and an example are specified. After the rationale, implications and an example are added the principles are validated within the organisation. The next two steps ('apply principles' and 'manage compliance') focus on applying the principles and making sure the organisation complies with them. Lastly, Greefhorst and Proper (2011) propose an eighth step: 'handle changes'. They argue that defined principles can change because drivers can change and, therefore, a change management process should be in place. One can also argue that the eighth step is not a separate step but step seven should be connected to step one (creating a lifecycle) since the identification of new and changing drivers is part of step one: 'determine drivers'. This research will focus on applying step one till step five. In general, principles are often focused on a specific domain. In this paper, our aim is to analyse principles specifically for the BRM domain. According to Zoet (2014), BRM comprises the elicitation, design, specification, verification, validation, deployment, execution, governance and evaluation of business rules. A detailed explanation of the BRM processes can be found in Zoet (2014). However, to ground our research, a summary is provided here. The value proposition (end result) of a business rule set is delivered when the business rule set is executed during the execution process. Business rule sets can provide the following value propositions: classification, assessments, diagnosis, monitoring, prediction, configuration design, modelling, planning, scheduling, and assignment (Breuker, 1994). Before the business rule set can be executed, it first needs to be elicitated, designed, specified, accepted, and deployed. The elicitation process exists out of two main tasks: determine scope and identify sources. In the task determine scope, the value proposition of the business rule set is determined. After the scope has been determined, the data sources that influence the business rule set have to be identified. Data sources can be sources such as human experts, documentation, laws, and regulations. After the data sources have been determined the design process starts. First, the scope is decomposed by means of a business rules architecture. The business rules architecture is a structure which decomposes scope in multiple fine-grained modular business rule sets that adheres to the single responsibility principle (DeMarco, 1978). The purpose of the context architecture is to create a normalized business rule set in which individual business rule sets can be changed without affecting other parts. For example, the scope is "determine candidate profile" which can be decomposed into multiple business rule sets: "determine candidate personality rating", "determine candidate cognitive rating", and "determine candidate maturity rating."

After the business rules architecture is created it is verified (to check for semantic / syntax errors) and validated (to check for errors in its intended behaviour). After the validation of the business rules architecture, a fact model and the business rules are defined for each individual business rule set. Furthermore, the verification and validation of the fact model and business rules take place per business rule set. After each individual business rule set has been validated, also, the scope (the combination of business rule sets) as a whole is validated. Until this moment, the scope, business rule sets, business rules and fact models have been modelled in an implementation-independent language during the different BRM processes. An implementation-independent language is considered as: "*a language that is not tailored to be applicable to a specific information system*" (Zoet & Versendaal, 2013). An implementation-dependent language, on the other hand, is defined as: "*a language that is tailored to be applicable to a specific information system*" (Zoet & Versendaal, 2013). Implementation-dependent business rule languages have a specific grammar, which can only be interpreted by a specific system. Examples of such systems are Corticon (2015), Idiom (2015), and Visual Rules (2015). The translation from an implementation-independent language to an implementation-dependent language is the goal of the deployment process. The last BRM process is the execution process which transforms a platform-specific rule model into the value proposition it must deliver.

To structure the identified principles, the dimensions and ontological foundations of the information systems framework are applied (Weber, 1997). The extended information system framework has been proposed by Strong and Volkoff (2010), describing that principles can be categorized into four categories: 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). Organizational structures are the roles, control and organizational culture represented within organizations or within solutions (Strong & Volkoff, 2010). Physical structure elements describe the physical technology and software in which the deep structure is embedded (Weber, 1997). Surface structure elements describe the interface between the information system and its users.

3   RESEARCH METHOD

The goal of this research is to identify principles that limit the freedom with regards to BRM. In addition to the goal of the research, also, the maturity of the research field is a factor in determining the appropriate research method and technique. The maturity of the BRM research field, with regard to non-technological research, is nascent (Kovacic, 2004; Nelson et al., 2010; Zoet, 2014). The focus of research in nascent research fields should lie on identifying new constructs and establishing relationships between identified constructs (Edmondson and McManus, 2007). Summarized, to accomplish our research goal, a research approach is needed in which a broad range of possible principles for BRM are explored and combined into one view.

Adequate research techniques to explore a broad range of possible solutions to a complex issue and combine them into one view when a lack of empirical evidence exists are group-based research techniques (Delbecq and van de Venz 1971; Okoli and Pawlowski 2004; Ono and Wedemeyer 1994; Murphy et al., 1998). Examples of group based techniques are 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 the use of face-to-face versus non-face-to-face approaches. Both approaches have advantages and disadvantages, for example, in face-to-face meetings, provision of immediate feedback is possible. However, face-to-face meetings have limitations 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 (focus groups) and non-face-to-face (Delphi study) technique.

4   DATA COLLECTION AND ANALYSIS

Data for this study is collected over a period of six months, through three rounds of focus groups (round 1, 2 and 3: focus group) and a three-round Delphi study (round 4, 5 and 6 Delphi study), see Figure 1. Between each individual round of focus group and Delphi Study, the researchers consolidated the results (round 1, 2, 3, 4, 5, 6 and 7: research team). Both methods of data collection are further discussed in the remainder of this section.

4.1   Focus Groups

Before a focus group is conducted; a number of key issues need to be considered: 1) the goal of the focus group, 2) the selection of participants, 3) the number of participants, 4) the selection of the facilitator, 5) the information recording facilities, and 6) the protocol of the focus group. The goal of the focus group was to identify principles for BRM. The selection of the participants should be based on the group of individuals, organizations, information technology, or community that best represents the phenomenon studied (Straus and Corbin, 1990). In this study, organizations and individuals that deal with a large amount of business rules represent the phenomenon studied. Such organisations are often financial and government institutions. During this research, five Dutch government institutions participated. Based on the written description of the goal and consultation with employees of each

government institution, participants were selected to take part in the three focus group meetings. In total, twelve participants took part who fulfilled the following positions: three enterprise architects, two business rule architects, three business rule analysts, one project manager, one IT architect, and two policy advisors. 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 selected facilitator has a Ph.D. in BRM, has conducted eight years of research on the topic, and has facilitated many (similar) focus group meetings before. Besides the facilitator, three additional researchers were present during the focus group meetings. One researcher participated as 'back-up' facilitator, who monitored if each participant provided equal input, and if necessary, involved specific participants by asking for more in-depth elaboration on the subject. The remaining two researchers acted as a minute's secretary taking field notes. They did not intervene in the process; they operated from the side-line. All focus groups were video and audio recorded. A focus group meeting took on average three hours. Each focus group meeting followed the same overall protocol, each starting with an introduction and explanation of the purpose and procedures of the meeting, after which ideas were generated, shared, discussed and/or refined.

Research Team	Experts: Focus Group	Experts: Delphi Study
Round 1: Preperation Focus Group		
	Round 1: Elicitation	
Round 2: Consolidation		
	Round 2: Elicitation, Refinement and Validation	
Round 3: Consolidation		
	Round 3: Elicitation, Refinement and Validation	
Round 4: Consolidation		
	Round 4: Elicitation, Refinement and Validation	
Round 5: Consolidation		
	Round 5: Refinement and Validation	
Round 6: Consolidation		
	Round 6: Refinement and Validation	
Round 7: Consolidation		

Figure 1.   Research Approach

Prior to the first round, participants were informed about the purpose of the focus group meeting and were invited to submit their current principles applied to the BRM problem space. Each of the participants submitted their current principles in advance to the first focus group meeting. This resulted in the submission of a large number of principles: 343. This was due to the fact that two of the participating organisations submitted all their currently applied principles. The reason behind this is that the organizations wanted to establish if their current principles also influenced the design of a BRM solution. Before the first focus group meeting the researchers already grouped similar principles and created a set of principles that in their opinion did not relate to BRM solutions. During the first focus group meeting, participants first explained their submitted principles after which the set of unrelated principles was discussed. For each principle, the group discussed whether the principle was related to a BRM solution or not. The last part of the focus group meeting was committed to defining new principles

where participants thought they were missing from the already identified selection of principles. Grouping and analysis of the results of the first focus group resulted in 99 principles. For each proposed principle, the principle ID, label, rationale, classification, and instantiations were discussed and noted, see table 1 for an example.

Principle ID:	019
Principle label:	Separation of the know and flow.
Description:	This principle implies that the process (flow) should be designed, specified, and implemented independently from the business rules (know). Laws and regulations (business rules) are subject to a higher frequency of change (know), however, the underlying processes have a lower frequency of change (flow).
Example(s):	Different insurance products and governance services are provided via the same process (flow) but the result depends on different logic (know). For example, the process to determine child benefits, elderly benefits and housing benefits all follow the same process: determine entitlement of the allowance, determine the amount of the allowance and determine the duration of the allowance. The business rules applied to determine the amount of child benefits differs from the business rules applied to determine elderly benefits.
Rationale:	Business rules (know) have a higher frequency of change than business processes (flow). Additionally, business rules can often be applied in multiple business processes. Applying this principle, will 1) enable reuse of business rules in different processes and 2) ensure that processes and business rules can change at their own pace. This will also result in changes being implemented faster due to fewer dependencies between 'the know' and 'the flow'.
Classification:	Deep structure, physical structure and surface structure.

Table 1.   Example Principle: Separation of the know and flow.

After the first focus group, the researchers consolidated the results. Consolidation of the results comprised the detection of double principles and incomplete principles. This process is executed as follows. All principles have been transformed into columns and rows in an (ordinal) comparison table. An example snapshot that was utilized has been added in table 2.

		Description	Example	Rationale	Classification
Principle 67	Description	=/			
	Example		=/		
	Rationale			==	
	Classification				=/

Table 2.   Snapshot Meta-Model Comparison Table.

For each principle the description, example, rationale, classification, and goal are compared by three researchers. When double principles or incomplete principles are discovered this is noted and added to the results of the consolidation. In situations where the three researchers didn't agree on the comparison, the fourth researcher compared the principles and discussed the results with the first three researchers until consensus was reached. For clarification purposes, one specific type of doubling should be explained here: reversed rationales. An example of a principle with reversed rationales is principle 1: *"automated decisions where possible, supported decisions if necessary."* This principle states that most decisions must be executed automatically. This is only possible when the decisions are highly structured. For two organizations this is the case and therefore, they argued for adding principle 1. The remaining organisations have less structured decisions and, therefore, argued for the following principle: *"human decisions are preferred unless the business knowledge is fully specified."* Both principles have the same goal: decisions which can be automated should be automated and decisions that cannot be automated

shouldn't be automated. On the one hand, one can argue for adding both principles such that organizations can choose from the catalogue. On the other hand, this would lead to a significant and unnecessary growth of the principle catalogue. In consultation with the participants, it was agreed to use one specific formulation.

The results of the consolidation were sent 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 four questions: 1) "Are all principles described correctly?" (in terms of the principle label, accompanied examples, and its rationale), 2)"Do I want to remove a principle?" 3) "Do we need additional principles?", and 4) "How does the principle affect a BRM implementation?" During the second focus group, the participants discussed the 99 principles. The group started to discuss the usefulness of the principles and concluded that such a high number of principles was not desirable. This resulted in the removal of 77 principles, resulting in 22 principles which were deemed useful by the participants. The principles were removed because of one of the following reasons: 1) the principle is not BRM-specific but an IS general principle, 2) the principle is not BRM-specific but for Information Security, 3) the principle is not BRM-specific but data management specific, 4) the principle is overlapping or part of another principle or 5) the principle is the negative formulation of another positively formulated principle. Again, the researchers consolidated the results and send them to the participants two weeks in advance. During the third focus group, the participants discussed the remaining 22 principles. The discussion did not lead to new principles and focused on further refinement of the existing principles in terms of descriptions, rationale, classification, and goals of each of the 22 principles.

4.2 Delphi Study

Before a Delphi study is conducted, also a number of key issues need to be considered: 1) the goal of the Delphi study, 2) the selection of participants, 3) the number of participants, and 4) the protocol of the Delphi study. The goal of the Delphi study was twofold. The first goal was to validate and refine existing principles identified in the focus group meetings, and the second goal was to identify new principles. Based on the written description of the goal and consultation with employees of each organisation, participants were selected to take part in the Delphi study. In total, 41 participants took part. 29, in addition to the twelve experts that participated in the focus group meetings, were involved in the Delphi Study. The reason for involving the twelve experts from the focus groups was to decrease the likelihood of peer-pressure amongst group members as could have been the case in the focus group meetings. This is achieved by exploiting the advantage of a Delphi Study which is characterized by a non-face-to-face approach. The 29 additional participants involved in the Delphi Study had the following positions: one software engineer, two project managers, one enterprise architects, nine business rules analyst, four policy advisors, one IT-architects, five business rules architects, two business consultants, one functional designer, one tax advisor, one legal advisor, and one legislative author. Each of the participants had, at least, two years of experience with business rules.

Each round (4, 5, and 6) of the Delphi Study followed the same overall protocol. Each participant was send the list of principles and was asked to assess each principle in relationship to two questions: 1) *"When needed, can you apply the principle in your organisation?,* and 2) *"Can you name an example of the application of this principle or one with a reversed rationale?"*. Additionally, the participants were asked to answer the following questions: *3) "Do you know additional principles? / are any principles missing?"* After the participants submitted the results they were compared and consolidated in the same manner as during the focus groups. If the answers of the participant were ambiguous, researchers contacted the participant to clarify the answers. In three rounds of Delphi Study, this resulted in no additional principles. The submitted principles already were included but in a reversed rational. It led to a sharper formulation of the description, example and rationale of the principles.

5 RESULTS

In this section, the final results of the focus group and Delphi study are presented per category. After the presentation of a summary of the principles per category, see table 3, the principles themselves are presented. The principles have been categorized along the dimensions of the ontological foundations of the extended information systems framework (Strong and Volkoff, 2010), which is elaborated in section two.

	Organizational structure	Deep structure	Physical structure	Surface structure	Category#
Principle 01		X	X	X	4
Principle 02		X	X		5
Principle 03		X	X		5
Principle 04	X		X		6
Principle 05		X			2
Principle 06	X				1
Principle 07	X	X	X		7
Principle 08	X	X	X		7
Principle 09				X	3
Principle 10		X			2
Principle 11				X	3
Principle 12	X				1
Principle 13	X		X		6
Principle 14		X			2
Principle 15	X				1
Principle 16	X		X		6
Principle 17		X			2
Principle 18	X	X	X		7
Principle 19	X				1
Principle 20		X			2
Principle 21	X	X	X	X	8
Principle 22		X			2

Table 3.   Classification of identified principles

5.1   Reduction of freedom: Principles that affect the organisational structure (category 1)

Four identified principles affect only the organisational structure: 6) Traceable decisions, 12) Gaming only permitted between 09:00 AM and 17:00 PM, 15) Create once and use multiple times, and 19) Separation of the know and flow. The 6th principle stresses the importance of being able to trace how decisions were taken. To be able to do so, the activity's input, applied business rules, and output must be stored. As a result, it is possible to check historic data on how certain activities were performed, resulting in decision making. Furthermore, the 12th principle prescribes that, where necessary, gaming with business rules should be limited. When organisations are unable to do so, clients can experiment with different options in order to achieve the desired result from business rules. On the other hand experimentation with business rules should be allowed for by employees. The 15th principle focuses on the utilization of organization-wide reuse of business rules. Structured implementation-independent business rules need only to be recorded once. The business rules are managed in one central location. Processes in which these business rules are used contain a reference to the business rules repository. Lastly, the 19th principle dictates that the know and flow should be separated, which is described in-depth in our example in table 2.

5.2 Reduction of freedom: principles that affect the deep structure (category 2)

Five identified principles affect only the deep structure: 5) Ownership of a decision is defined, 10) Reuse before buying and creating software, 17) Flexible decisions, 20) Develop business rules from a management perspective rather than an implementation perspective, and 22) Include compliancy in designing products and/or services. The 5th principle focuses on the explicitation of ownership and/or accountability per decision. Organizations often do not define the roles and responsibilities of employees, functions or departments with respect to a specific decision. Blenko and Roger (2010) identified this problem and addressed it by creating RAPID. RAPID is a technique that can be applied to define which role each department, team or person has with regards to a specific decision. In their research, Blenko and Roger showed that a proper allocation of decision rights increases organizations effectiveness. Furthermore, the 10th principle prescribes that organisations should identify what software (business rules engines) they already possess before buying or building new software. The rationale behind this is that many organizations have their business rules deployed in multiple systems and therefore have to adapt them at multiple places when they change. If one business rule engine could be used this problem can be prevented. The 14th principle states that Laws and regulations must be implemented in a context structure. A context is a related set of knowledge in terms of business rules and facts (with a maximum internal cohesion and a minimal external coherence). The relationship between different contexts is presented in a derivation structure. Such structures are also referred to as business rule architectures. The 17th principle states that employees should be able to override decisions during execution. The rationale behind this is that employees can correct and enhance the business rules while working with them. Moreover, the 20th principle prescribes that the development of business rules should take into account its management instead of its implementation within a specific system. When developing business rules the management aspect concerning managing business rules post-deployment should be taken into account. Therefore, cooperation between the business rule designers and business rule operators should be facilitated. Lastly, the 22nd principle states that the design of products and/or services should also take into account compliance by ensuring it adheres to external legal and internal policy requirements. By doing so, it is possible to mitigate risks and to explore to what extent quality is achieved and whether there should be improved upon the service and/or product or not.

5.3 Reduction of freedom: principles that affect the surface structure (category 3)

Two identified principles affect only the surface structure: 9) P.E.N.S. criteria are determined for each business rule set, and 11) Best-of-suite approach. The 9th principle addresses the language properties for each business rule set. Different properties exist with regards to implementation-dependent and implementation-independent business rule sets. In general, four properties can be distinguished: precision, expressiveness, naturalness and simplicity. Precision indicates the degree to which the meaning of a text is directly clear from its textual form. This implies that the language (Controlled Natural language, also referred to as CNL) has to be unambiguous. Expressiveness indicates the range of statements that a certain CNL is able to express. In other words, the degree to which communication can be captured. Naturalness indicates the degree to which a text resembles a natural language. In other words, the statements of a CNL should be understandable and readable for speakers of the concerned natural language. Lastly, simplicity indicates the degree of simplicity to define the language in terms of syntax and semantics. Moreover, simplicity covers the effort needed to implement the language in software. The indicator which is used for simplicity is: the number of pages needed to describe the language in an exact and comprehensive way. Finally, the 11th principle describes a best-of-suite approach. The rationale behind the best-of-suite approach is the integrative power of a suite. Because of the fact that all function of the system are integrated connecting different concepts, i.e. laws, business rules and decision services is easier compared to a non-integrated system.

5.4 Reduction of freedom: Principles that affect the deep, physical and surface structure (category 4)

One identified principle affects a combination of the deep, physical, and surface structures: 1) automated decisions where possible, supported decisions if necessary. The 1st principle dictates that processing of decisions takes place automatically where possible. Where this is not possible or desirable, decisions are processed by employees with decision support delivered by the system. The automation of decision-making is a highly desired concept, but in many cases, it failed. However, one of the participants stated: *"On the one hand tax regulation is specified in such a manner that over 70% of the decisions can be executed automatically and we already have this in place, on the other hand, customs regulation is specified in such a manner that less than 30% of the decisions can be executed automatically."* Other participants agreed and also explained how they already execute specific decisions in a fully automated manner. The requirement to do so is that the decisions are highly structured.

5.5 Reduction of freedom: Principles that affect the deep and physical structure (category 5)

Two identified principles affect a combination of the deep and physical structures: 2) IT does not formulate business rules, and 3) No big-bang but iteration approaches for business rules projects. The 2nd principle prescribes that business rules should always be designed by someone from the business domain (non-IT-professional). The IT department may not change business rules through which the decision logic is (accidentally) adapted. Furthermore, the 3rd principle addresses the way that BRM projects are planned. The rationale behind this principle is that business rules are business objects that are characterized by a high change frequency. When waiting to implement all business rules at once, there is a high probability that, meanwhile, multiple business rules already have changed.

5.6 Reduction of freedom: Principles that affect the organisational and physical structure (category 6)

Three identified principles affect a combination of the organizational and physical structure: 4) Authorization for decision-making, 13) Sharing knowledge concerning the execution of laws, regulations, and policies with employees and clients, and 16) Communication with the same standards wherever possible, communication with different standards where desirable. The 4th principle prescribes that organisations should implement authorization mechanisms for decision-making so that only authorized employees/agents can make decisions. This avoids decision-making by employees, which are not allowed for decision-making. Furthermore, the 13th principle states that organisations should share their knowledge concerning the design and execution of laws, regulations, and policies with clients. Lastly, the 16th principle focuses on the utilization of communication standards (BR-related languages). Communication between stakeholders which are involved in the BRM processes must be aligned. Where possible, the same terms, in different situations should have the exact same definitions. This can be supported by means of a centralized list (i.e. a vocabulary) with definitions that can be utilized by different stakeholders. Where desirable, the same terms have different definitions in different situations. For this, a translation has to be made for each 'different' translation of the definition and added to the centralized list.

5.7 Reduction of freedom: Principles that affect the organisational, deep and physical structure (category 7)

Three identified principles affect a combination of the organizational, deep, and physical structures: 7) Data is recorded according to two-time dimensions, 8) All business rules must refer to a source, and 18) Utilize government-wide standards. The 7th principle focuses on the temporality of decisions and the data it uses. Data logging needs to support retrospective reconstruction and processing. A distinction is made between the validity dimension (time on which data and business rules are valid) and transaction dimension (the timeline where the timing of registration is located). The transaction dimension is always

applicable for each data record, the validity dimension is only applicable when desired. Furthermore, the 8th principle dictates that all elements of a business rule must be marked with a source. This is due to the fact that the building blocks of business rules cannot and may not be assumed. There must always be a reference that indicates the source. Business rules concern the functioning of an organization and to guide this, business rules are derived from business goals and objectives and are shaped by various influences grounded in laws, regulations, and policies. Lastly, the 18th principle prescribes the use of government-wide standards. Government standards describe a structured way in which data and business rules should be handled or how processes should be performed.

5.8 Reduction of freedom: Principles that affect all structures (category 8)

Lastly, one identified principle affects all four structures: 21) transparency concerning decision-making for clients and users. In many cases regulation now forces organisations to provide an explanation of how they actually arrived at a specific decision. This implies providing details on decision logic and laws and regulations that affected the decision-making. To provide these details organizations do not only have to adjust the manner in which they represent the business rules but also store additional details and change supporting organisations which manage the traceability links to laws and regulations.

6 CONTRIBUTIONS AND LIMITATIONS

The design and implementations of more and more BRM solutions justify the search for guidance to design such solutions. In multiple disciplines, such as BPM, industrial engineering and system engineering principles are applied to guide design. In this study, we set out to identify principles which are useful to guide the design of BRM solutions. From a research perspective, our study provides a fundament & principle catalogue for further exploring additional principles and the effect of principles on the design of BRM solutions. Designed artefacts must be measured by predefined variables. With regards to the principle catalogue, 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 (Hevner et al., 2004). If a principles catalogue is incomplete or lacks mutual exclusivity its value decreases. Further research will focus on the perspective of the other variables.

From a practical perspective, our study provides organizations and (enterprise) architects within organizations with a set of principles that can be applied to guide the design of BRM solutions. It offers a framework that can structure thinking about the solution that needs to be implemented.

Several limitations may affect our results. The first limitation is the sampling and sample size. The sample group of participants is solely drawn from government institutions in the Netherlands. The context of government institutions has been chosen, since they deal with the implementation of large amounts of business rules derived from laws and regulations. Therefore, we believe that government institutions are representative for organisations implementing business rules. Still, further generalization towards non-governmental organizations is recommended in future research. The Dutch context of this study must also be considered in assessing the generalizability of findings. While we believe that the principle catalogue can be applicable to other contexts (i.e. industries or countries), the specific actions based on the principles can vary.

Taken the sample size of 41 participants into account, this number needs to be increased in future research. This research focused on identifying new constructs and establishing relationships given the current maturity of the BRM research field. Although the research approach chosen for this research type is appropriate, research focusing on further generalization must apply different research methods, such as quantitative research methods, which also allow us to incorporate larger sample sizes to validate our findings.

7   CONCLUSION

In this paper, we set out to find an answer to the following question: "Which principles are useful to guide the design of a business rules management solution?" In order to answer this question, we conducted a study combining a three round focus group and three round Delphi Study. Twelve participants, employed by five governmental institutions, took part in the focus group. In three rounds 22 principles have been identified. After the focus group, three rounds of Delphi study have been conducted. In total 41 participants took part in the Delphi Study in which no additional principles have been identified but further refinement of the existing principles occurred.

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