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Completed Research Paper

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Abstract

Business Rules Management (BRM) is increasingly being applied in the governmental context. However, currently, many of those governmental institutions apply different BRM processes, but are expected to work together in their task of delivering products and services to citizens and companies in the Netherlands. An initiative from the Dutch government was started with the goal to investigate currently applied processes and develop a BRM reference process to promote cooperation. This paper elaborates upon the process of comparison of currently applied BRM processes and development of the BRM reference process for the Dutch government. The resulting BRM reference process consists of seven main processes with twenty sub-processes and a common vocabulary which can guide (Dutch) governmental organizations to design and implement their BRM solution as well as to achieve better cooperation due to increased commonality. In terms of future research, the emphasis should lie on more thorough validation, using quantitative research methods, but we argue that other industries should be explored as well.

Keywords: *Reference Process, Business Rules Management, Government*

Introduction

Many business services nowadays heavily rely on business decisions and business logic embedded in information systems. Herewith, organizations aim to, for example, increase compliance, modernize IT chains, reduce inconsistent and expensive customer interaction, and facilitate law and policy implementation (Bajec & Krisper, 2005; Shao & Pound, 1999). A business decision is defined as: "*A conclusion that a business arrives at through business logic and which the business is interested in managing*" (OMG, 2016b). Moreover, business logic is defined as: "*a collection of business rules, business decision tables, or executable analytic models to make individual business decisions*" (OMG, 2016a). Both concepts of business decisions and business logic are often seen in relation to Business Rules Management (BRM), as BRM focuses on the elicitation, design, specification, verification, validation, deployment, execution, evaluation and government of business decisions and business logic (Bajec & Krisper, 2005; Schlosser, Baghi, Otto, & Oesterle, 2014; Zoet, 2014).

In the research domain of BRM, most research studies emphasize on the technological aspects (Kovacic, 2004), thus lacks a well-balanced mix of research between technology and methods & techniques to be applied in the context of BRM (Nelson, Peterson, Rariden, & Sen, 2010). In the same light, Arnott and Pervan (2005) conducted an extensive literature review with regards to the knowledge base in 2005, concluding that the research domain has lost its connection with industry some time ago and research output with practical relevance is scarce. In 2014, Arnott and Pervan (2014) revisited the knowledge base to conclude that a transition is happening to a more practical-oriented approach, where research studies utilize more design-science as a method, to, amongst other reasons, increase practical relevance. This conclusion was further strengthened by the results of the extensive work on methods and concepts for BRM from Zoet (2014). Based on these arguments, we conclude that the current knowledge base could benefit from more practical-oriented contributions.

BRM is applied in several industries, i.e. insurance, higher education, financial services, healthcare, transportation, utilities, human resources, enterprise resource planning, and the public sector. These industries utilize BRM to support the implementation of products and services concerning the determination of eligibility, assessments, calculations, complex comparisons, inspections with regards to payments, benefits, transfers, rights and obligations, and licenses and permits. Within this context, the Dutch government issued a large research program on how BRM is applied and could be improved. One of the main goals of this research programme was to investigate and make explicit the current best practices of governmental agencies and define a BRM reference process with the goal to 1) provide an overview of the organization's current situation, 2) achieve a common language to describe/discuss their BRM processes and 3) compare practices applied by the participated organizations. A BRM reference process aims to guide the design and implementation of BRM by providing and suggesting activity decomposition, coordination guidelines, and artifacts (Schuster, Georgakopoulos, Cichocki, & Baker, 2000). Translating this to a more practical orientation, a BRM reference process should contain possible business processes, sub-processes, roles, and artifacts that are processed to implement business decisions and business logic.

The current body of knowledge with regards to BRM reference models is limited, but several models already exist. Baggi, Schlosser, Otto and Oesterle (2014) describe three different reference models, one from an architectural perspective, one from a functional perspective, and one from a process perspective. Furthermore, Bajec and Krisper, (2005) describe the perspective of BRM between enterprise modeling and IS development. Zoet and Versendaal (2013) describes BRM processes from a service systems perspective, and Smit and Zoet (2016) describe BRM from a capability perspective. However, according to Rosemann and van der Aalst (2007), a reference model usually focuses on a specific application area or context, which also increases its chances of successful adoption (Cleland-Huang, Gotel, Huffman Hayes, Mäder, & Zisman, 2014). Therefore, in this paper, we focus on the definition of a BRM reference process for the governmental context. To achieve this, we addressed the following research question: "*Which (sub-)processes constitute a Business Rules Management process for the Dutch governmental agencies?*"

The remainder of this paper is organized as follows: First, we provide insights into the details of reference process design and how it can be contextualized for BRM theory. This is followed by the research method used to construct the BRM reference process. Furthermore, the collection and analysis of our research data are described. Subsequently, our results which led to our BRM reference process, and the BRM reference process itself, are presented. Finally, we discuss which conclusions can be drawn from our results, followed by a review of the research methods utilized and results of our study and propose possible directions for future research.

Background and Related Work

Business decisions and business logic are an important part of an organization's daily activities. To increase grip on business decisions and business logic, organizations search for a systematic and controlled approach to support the elicitation, design, specification, verification, validation, deployment, execution, governance, and evaluation of business decisions and business logic. Such an approach can be defined as Business Rules Management (BRM), which is a combination of methods, techniques, and tools (Bajec & Krisper, 2005; Boyer & Mili, 2011; Graham, 2007; Morgan, 2002; Ross, 2003; Zoet, 2014). In the current body of knowledge, business decisions and business logic are described using different concepts. For example, derivation business rules, operational decisions, business knowledge, scope design, and derivation structure. In this paper, we adhere to the definitions on business decisions and business logic as provided by the OMG, see section one (2016a; 2016b). In addition, we adhere to the concepts as described in (Smit & Zoet, 2016) to describe the various artifacts to design and specify business decisions and business logic. A business decision can exist out of multiple business decisions, for example, the business decision '*determine the amount of child benefits*', which is derived from three sub-business decisions; '*determine wage of parents*', '*determine family composition*', and '*determine the age of child*'. The overall decision is referred to as a scope. The relationships between the four decisions in this example are described by means of a derivation structure. Moreover, business logic describes the knowledge required to execute the business decision. The different concepts to specify business logic are *business rules*, *fact types,* and *fact values* (Von Halle & Goldberg, 2009).

To create a reference process, three possible approaches can be applied; 1) 'reference model combination', 2) 'reference model building', and 3) a hybrid approach (Rosemann & van der Aalst, 2007). The first approach proposes a reference model based on the combination of theory identified from the body of knowledge without involving the application environment in the building process. The second approach proposes a reference model based on the best practices acquired from the application environment without influences from the body of knowledge. The hybrid approach consists of a combination of the two approaches. In this paper, we choose to adopt the hybrid approach.

In addition to the selection of one of three approaches, eight decisions about the characteristics of the reference model need to be taken (Rosemann & van der Aalst, 2007). First, the scope of the model needs to be determined. The scope can vary between a general scope or specific scope for a target domain or application (i.e. the food industry in general versus traceability support of fruit distribution in IT systems). Within the scope of the reference process, the granularity needs to be determined (i.e. number of levels of decomposition detail, processes, sub-processes). The appropriate level of granularity is important as over-generalization of a reference model could lower adoption by the application environment. Furthermore, the views of the reference model need to be determined (i.e. process, data, objects, and organization). This is an important factor as well as different views, carry guidance information for different stakeholders. Therefore, when constructing a reference model, it is important to assess what information needs to be presented for each stakeholder, which is represented in one or multiple views. Based on the views depicted in the reference model, also the degree of integration between these views needs to be determined (i.e. which views are and are not related, and what inter-model relationship types exist). Moreover, the user groups of the reference model in terms of internal versus external (commercial) use have to be determined. Lastly, the manner in which the reference model and related explanation are shared with stakeholders could also influence the adoption, thus both the availability of the model (i.e. paper, tool-based, web-based) and the availability of further textual explanation of the model should be determined.

Since we apply a hybrid approach, we explore the existing literature on BRM (reference) processes. In the work of Zoet and Versendaal (2013), a BRM-related framework is proposed that contains a selection of service systems that focus on the processes of 1) mining 2) cleansing, 3) design, 4) verification, 5) validation, 6) improvement, 7) deployment, 8) execution, 9) monitoring, 10) audit and 11) version of business logic along with their corresponding input data, goal, output data and responsible roles. Furthermore, the work of Schlosser, Baghi, Otto, and Oesterle (2014) presents a somewhat different view of the application of BRM by proposing a functional reference model, focusing on a comprehensive view of the possible functionality of BRM based on design science research. Their functional reference model contains three perspectives; 1) BRM Process Perspective, 2) BRM Functional Architecture Perspective, and 3) BRM Business Goal Perspective. Within the BRM Process Perspective, several tasks are identified and elaborated; 1) requirements analysis, 2) authoring, 3) change management & validation, 4) monitoring, 5) deployment & implementation, and

6) execution. Furthermore, several artifacts which are relevant during these tasks are mentioned, i.e. a business vocabulary, business process models, a rulebook, and business requirements. Bajec & Krisper (2005) aimed to describe a BRM scenario to support managing business logic in organizations in which they depict and elaborate upon the relationship between IS development, BRM and enterprise modeling. Their BRM scenario contains a selection of seven BRM processes; 1) acquisition, 2) capturing, 3) modeling, 4) analysis and classification, 5) consistency validation, 6) implementation and 7) maintenance and monitoring. In the work of (Smit & Zoet, 2016), a selection of nine capabilities is described that represent the BRM problem space; 1) elicitation, 2) specification, 3) design, 4) verification, 5) validation, 6) deployment, 7) execution, 8) monitoring, and 9) governance. See also the work of (Boyer & Mili, 2011; Graham, 2007; Morgan, 2002) for literature on BRM in which activities as part of BRM are described implicitly, or not in relation to BRM processes but to BRM in a general sense.

Research Method

The goal of this research is to propose a BRM reference process which can guide the design of BRM solutions at governmental institutions in the Netherlands. As stated in the previous section, eight decisions need to be taken before the reference model can be defined: 1) the scope of the model, 2) the granularity of the model, 3) the views in the model, 4) the degree of integration between the views, 5) the user groups addressed, 6) the internal versus external use of the model, 7) the availability of the model, and 8) the availability of detailed explanation with regards to the model. Each of the eight decisions will be discussed in the context of this study.

The scope of the BRM reference process, as elaborated upon earlier, is the Dutch government, in the context of governmental agencies. The reference process utilizes two levels of abstraction to illustrate processes and sub-processes and corresponding artifacts and limits the view to the process and artifacts views combined in both abstraction levels. The reference process aims to guide all stakeholders which are involved in the process, from law and policy authors until the roles responsible for the actual usage of the products and services containing the business decisions and business logic, however, the definition of such roles can vary largely between organizations so we choose not to define them in this research to ensure our research results do not impose certain roles and responsibilities. The intended use of the reference model is internal, however, the results could be utilized to develop other instances for other industries, thus will be made available for external use as well. Furthermore, the reference process and accompanied documentation derived from this study will be made available by means of a digital report in which all processes, sub-processes, goals, input per process, output per process, activities, input per activity, output per activity, and artifacts are elaborated upon in detail. As the target group for this reference process is the Dutch government, the digital report is required to be produced in Dutch.

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(s). In this study, BRM is considered in combination with the research field of reference processes. The maturity of the reference model-research field, in general, is very mature. However, the research field of BRM, in general, is less mature to 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 & Mcmanus, 2007).

To achieve our goal, we analyze the design and application of BRM processes in five case studies at five governmental agencies. Based on this round of data collection, a BRM reference process is constructed and proposed. Then, to increase the generalizability of the BRM reference process, three rounds of validation are conducted in the form of a focus group where subject-matter experts of all five case organizations participated.

Case study research is selected so that the researchers were able to gather data on how BRM is implemented in practice. Therefore, the case studies are exploratory of nature. The organizations are selected from a pool of Dutch governmental institutions that provide public administration services based on laws and regulations that are provided by the Dutch legislative governmental branches. Our study comprised a holistic case study approach, see also the work of (Runeson & Höst, 2009), featuring one context, the design and application of BRM to support decision making, and five cases within this context. The unit of analysis are the BRM processes of the individual case organizations. As the case study approach is exploratory of nature, the data collection and analysis consisted of secondary data (analysis) and semi-structured interviews, which is a combination of first and third-

degree data collection. This approach has several advantages and is thoroughly discussed in (Runeson & Höst, 2009).

Adequate research methods to explore a broad range of possible ideas and/or solutions to a complex issue and combine them into one view when a lack of empirical evidence exists consist of group-based research techniques (Delbecq & Van de Ven, 1971; Okoli & Pawlowski, 2004; Ono & Wedemeyer, 1994). 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 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 technique by means of applying case studies and three focus group meetings. In our study, the focus group sessions are conducted to validate and further refine the proposed BRM reference process.

Data Collection and Analysis

Data for this study is collected over a period of eight months, between May 2014 to December 2014, through five case studies and a three-round focus group design. Between each focus group round, a team of researchers consolidated the results for further elicitation, refinement and validation in the following focus group round. Both methods of data collection and analysis are further discussed in the remainder of this section.

Case Studies

The case studies at the individual organizations were performed over a period of four months, between May 2014 and August 2014. The case studies were designed to be performed in three phases. The first phase comprised the collection of secondary data at the case organizations. The second phase comprised the analysis of the secondary data that was collected in the first phase. The third and last phase comprised the field observations and semi-structured interviews at the case organizations which provided the research team with the possibility to clarify aspects that were identified to be missing in the secondary data provided by the case organizations in the first phase. The selection of the participants should be based on the group of individuals, organizations, information technology, or community that best represents the phenomenon studied (Strauss & Corbin, 1990). In the context of this study, this means that the phenomenon studied is represented by organizations and individuals within these organizations which deal with the design and execution of BRM processes, either manually or automated to handle large amounts of products and services. The five governmental agencies that participated in this research are, from here on, labelled as organization A, B, C, D and E. Combined, the participated organizations serve approximately 17 million clients and companies in the Netherlands with a large variety of e-services like the application, assessment, and notification regarding benefits, subsidiaries, visa's, permits, tax returns, vouchers, loans, grants, screenings, etc. The five governmental agencies are similar in nature in terms of business processes and how law and regulations must be implemented.

The first phase was carried out by a total of five research teams of two or three researchers per case organization, which visited the organizations to collect the secondary data. This yielded a large amount of secondary data which took the research teams two months to structure and analyze completely in the second phase. The analysis of the collected secondary data resulted in a lot of topics to be discussed or further clarified in the third phase of the case studies. During the third phase, we conducted in-depth semi-structured interviews at each case organization. At each case organization, a minimum of two subject-matter experts have been interviewed (in some cases three subject-matter experts were included). The subject-matter experts were asked to go through the BRM processes at their organization and were posed questions by the researchers when needed. The interview protocol has been tailored to each case organization to achieve the maximum result. For example, one interview with two subject-matter experts from case C focused on gathering more information on which artifacts were verified and validated in their corresponding processes as this was impossible to identify from the secondary data collected from this particular case organization. The interviews were all audio-taped and were protocolled within 48 hours. The results from the case studies were consolidated into a BRM process model of each of the participated organizations which served as important input for the focus group rounds.

Focus Groups

After the analysis and consolidation of the case study results were completed the focus groups were prepared and conducted between September 2014 and November 2014. As this study is part of a larger research project, the set-up of the focus groups is similar to that of (Smit & Zoet, 2016) but will be repeated to further clarify and ground our work in this study. Before a focus group is conducted, first, 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.

Before the focus groups were initiated, the research team started with the preparation of the topics to be discussed to ensure the BRM reference model is validated appropriately. Therefore, based on the individual BRM process models of the case organizations that were built and validated during the case studies, a first version of the BRM reference model was constructed. This was achieved by a coding process. For example, organization A had the following activity: '*Define derivation structure*', while organization C applies the activity: '*Define relationships between decisions*', and organization D applies the activity: '*Define decision tree*'. In the coding process, the term '*define derivation structure*' has been selected as the preferred concept, therefore the last two concepts have been re-coded.

During the coding process, we applied Mill's method of agreements and differences, which is an ordinal comparison method focused around the statement that the cause of a phenomenon is the characteristic or combination of characteristics found in each case (Mill, 1906). This means that when a certain activity only occurs in a process of one case organization it's still added to the reference model. The reason for this is that the reference process guides organizations with multiple possibilities in capabilities to choose from.

The goal of the focus group was to assemble and validate the BRM reference process for the Dutch government. We utilized the same selection of Dutch governmental institutions which collaborated in the case study stage, also to increase generalizability. Based on the written description of the goal and consultation with employees of each government agency, participants were selected to take part in the three focus group meetings. In total, seventeen participants took part, which fulfilled the following positions: two business rules architects, five business rule analysts, two policy advisors, three BRM project managers, one tax advisor, two enterprise architects, and two business consultants. Each of the participants had, at least, five years of experience with the design and application of BRM solutions. Each focus group round was chaired by one experienced facilitator. Besides the facilitator, three to five 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 researchers acted as a minute's secretary, taking notes. They did not intervene in the process. All focus group rounds were video and audio recorded. The duration of the first focus group session was 129 minutes, the second 180 minutes and the third 162 minutes. 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.

Prior to the first round, participants were informed about the purpose of the focus group meeting and were invited to study the case organization-specific BRM reference process, which was derived and consolidated from the case study results. In addition, the first version of the BRM reference process that was constructed from the collection of case-specific BRM processes was also included. All participants were asked to bring any comments, which came up while studying the results, with them to the first focus group meeting. The first round started with the presentations of the case-specific BRM process models derived from the case study results. After the individual presentations, participants discussed the usefulness of each (sub-)process in the BRM processes. Also, additional (sub-)processes were proposed. For each proposed (sub-)process, the 1) name, 2) description, 3) rationale, 4) artifacts and 5) organization-specific examples or instantiations were discussed and noted. After the first focus group, the researchers consolidated the results. Consolidation comprised the construction of the second version of the BRM reference process and the detection of redundant (sub-)processes (i.e. conceptually equal (sub-)processes). 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 (sub-)processes described correctly?", "2) Do I want to remove a (sub-)process?" 3) "Do we need additional (sub-)process?", and 4) "Does the (sub-)process contribute to the BRM reference process for the Dutch government"?" This process of conducting focus group meetings, consolidation

by the researchers and assessment by the participants of the focus group was repeated two more times (round 2 and round 3). During the third focus group meeting (round 3), saturation within the group occurred, leading to the consolidated BRM reference process for the Dutch government.

Results

In this section, the results of the conducted case studies and focus group sessions are presented. First, we report on the results of the case studies. This is followed by the results from the comparative analysis in which the case study results are compared. Lastly, we report on the results of the focus group meetings, which had the goal to validate our findings and come to a BRM reference process for the Dutch government.

Case Study Results

As mentioned in the data collection and analysis section, five case studies were conducted in three stages. Based on the analysis of both the secondary data and interview results, a BRM reference process is created that visualizes how the BRM processes are designed per case organization, see for example Figure 1 and Figure 2. In our results, we refer to a (sub-)process and artifacts in their singular form, while, in practice, it is possible that (sub-)processes are referred to in their plural form.
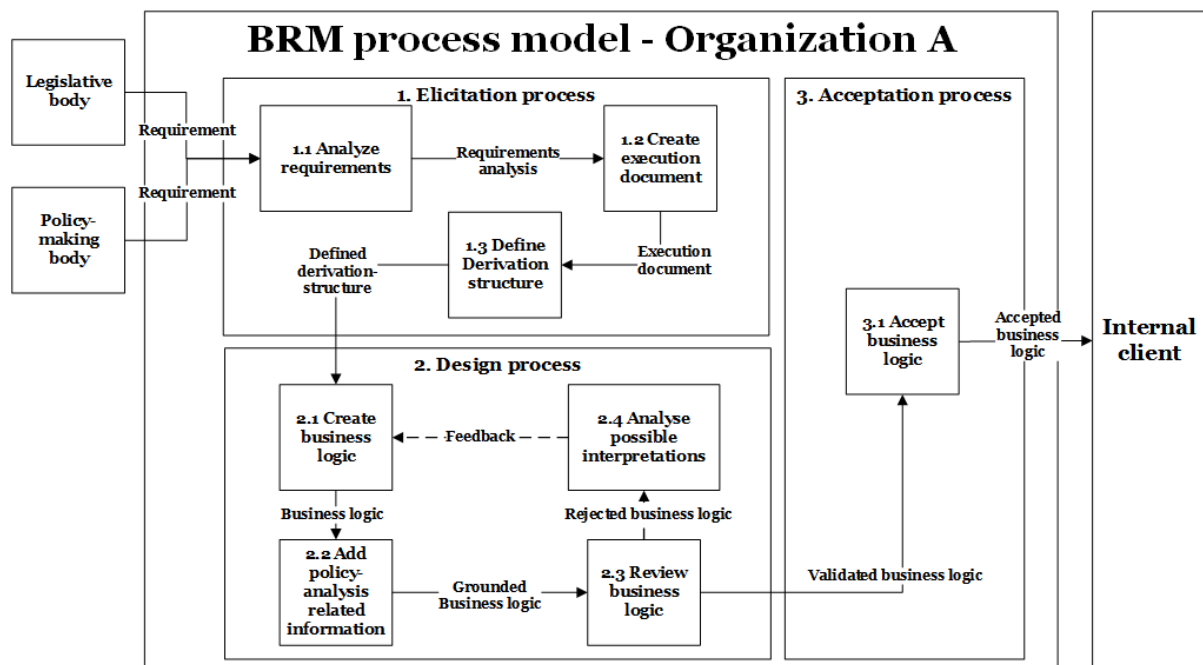

Figure 1. BRM process model consolidated from organization A

In total, the results of the case studies identified multiple similarities and differences between the involved case organizations. However, due to space limitations, we do not cover each individual difference but summarize the differences into topics. See the identification of similarities and differences in Table 1. In the comparison we identified whether the (sub-)process is 1) explicitly or 2) implicitly positioned in the BRM processes of the case organization, or 3) is not included. An example of a (sub-)process that is implicitly positioned in the BRM processes of case E is the process "Verify business rule", which is performed by the case organization. However, in their context, a 'product' is verified, which contains the business rule together with other components, thus is implicitly positioned in the BRM processes of the case organization.

Another activity that has to be performed by the research team as part of the consolidation is the transformation/mapping of the large variety of concepts applied by the case organizations to uniform concepts with clear definitions from literature. For example, a derivation structure is referred to as a 'decomposition' by case E, a 'knowledge model' by case C, an 'artefact' by case B, and a 'decision tree' by case D.
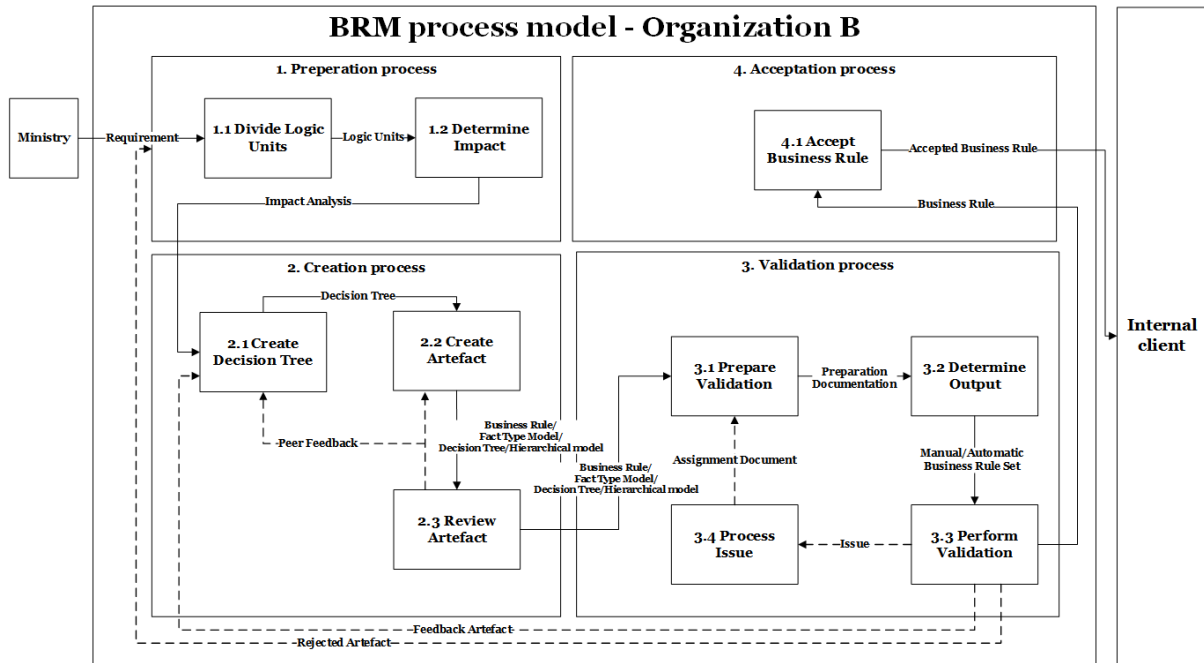
Figure 2. BRM process model consolidated from organization B

Focus Group Results

After all case study data was collected, analyzed and consolidated the results of all five case studies were used to prepare the first focus group session. The goal of the focus group sessions was to assemble and validate the BRM reference process, based on the participant's input and feedback.

One of the results of the consolidation was the initial BRM reference process, which was sent two weeks in advance before the start of the first focus group session. The initial reference process yielded much discussion in the first focus group session as the initial reference process did not take into account all the nuances between different processes at the different participated organizations. For example, the majority of the participated organizations did not incorporate the verification and validation processes after all the business decisions and business logic have been created. However, the participants corrected the reference process on how verification and validation is and should be applied. While not all participated organizations applied verification and validation as suggested, all participants agreed that verification and validation should be integrated into the actual design process. This discussion was followed by remarks about the sequentially of the verification and validation processes. Some of the participants argued that verification and validation are performed simultaneously, but also the manner in which both processes were applied was discussed intensely. After the facilitator clarified that the sequentially of both processes are very dependent on the technology applied by an organization, the participants agreed that the verification of an artifact should be performed before the validation of the artifact can be initiated. This was further grounded by the argument of some participants which stated that both capabilities and their underlying processes should not be merged but rather separated, maybe even performed by different roles. For example, a rule author, which is very proficient with regards to a given language to express an artifact is very capable to manually review artifacts on syntax or semantic errors (verification). However, this same rule author could be less capable of determining the actual lawfulness of the artifact (validation), which is in turn performed by a subject-matter expert with regards to that specific legal area. Moreover, many initial labels for processes, sub-processes, and artifacts were discussed upon and corrections were suggested by the participants. This led to the refinement and validation of the reference process after the first focus group session.

The main topic of discussion during the second focus group session was that the reference process contained too much detail in the implementation-dependent section as the participated organizations apply these processes differently. Based on this, the participants decided to only include the first level granularity (process and artifact) with regards to the implementation-dependent section of the BRM reference process. Therefore, the implementation-dependent side (deployment, execution, and partly the governance and evaluation processes) does not contain sub-processes (second-level granularity of the reference process). In addition, the participants stressed that a more explicit reference process is

needed with regards to the implementation-independent area of artifact development within BRM. These discussions led to the further refinement and validation of the reference process after the second focus group session.

The last and third focus group session mainly focused on further refinement in the correction of errors or changes in labels for both sub-processes and artifacts. The modifications were discussed with all participants and, where agreed upon, processed into the final BRM reference process for the Dutch government.

BRM Reference Process for the Dutch Government

Based on the data collection and analysis conducted in case studies and focus group sessions we propose the BRM reference process for the Dutch government. As can be observed from Figure 3, three different patterns are applied. The dashed areas in the left section of the reference process represent the role and responsibility of the client that instructs requirements. The white areas in the middle section represent the area where artifacts are processed in their implementation-independent language form. An implementation-independent language is defined as: "*a language that complies with a certain level of naturalness but has a delimited predefined expressiveness and is not tailored to be applicable to a specific automated information system*" (Zoet & Versendaal, 2013). The gray areas in the right section represent the area where the artifacts are processed in their implementation-dependent language form. An implementation-dependent language is defined as: "*a language that complies with a specific software formalism, has a delimited predefined expressiveness and is tailored to be interpreted by a particular information system*" (Zoet & Versendaal, 2013).
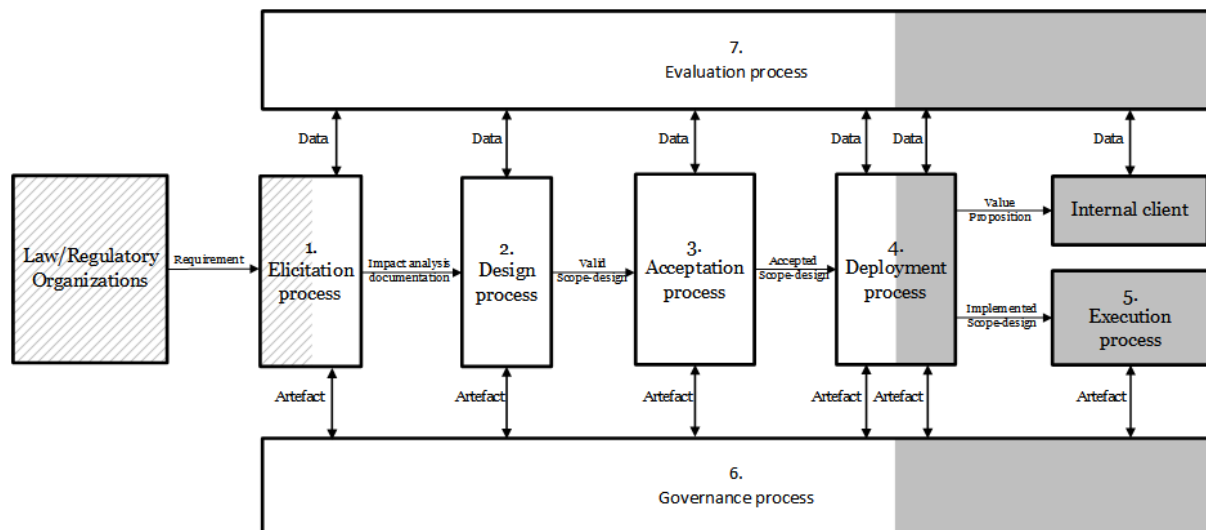
Figure 3. BRM reference process for the Dutch government – top-level abstraction perspective

1. The elicitation process

In the elicitation process, three sub-processes are identified: *1.1 determine scope*, *1.2 identify source*, and *1.3 conduct impact analysis*, see also Figure 4. The elicitation process, (sub-process 1.1), is triggered by an incoming requirement from one of the clients of the governmental agencies. The goal of this sub-process is to determine the relevant business decisions and business logic. The output of this sub-activity is a selection of sources that need to be analyzed in the subsequent BRM processes. In sub-process 1.2, all sources that correspond with the scope from 1.1 are identified and recorded. Based on both the scope from 1.1 and the relevant sources from 1.2, sub-process 1.3 aims to identify what impact is caused by the (new) requirement. The output of both 1.3 and the elicitation process, in general, is the impact analysis documentation which is input for the *2. Design process*. Impact analysis documentation contains, in detail, what artifacts, or parts of artifacts, need to be created, modified or deleted in order to meet the requirement.
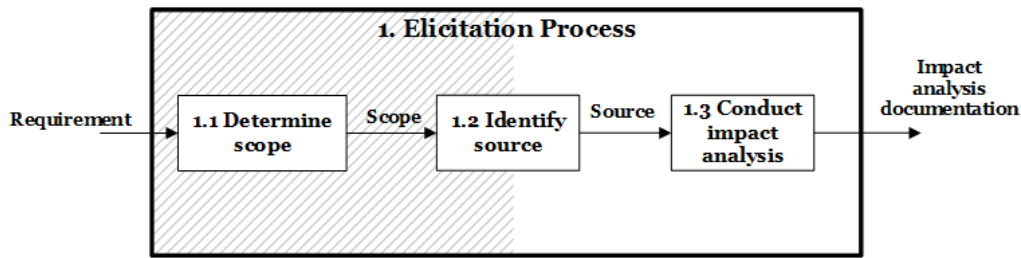
Figure 4. Detailed view of the *1. Elicitation process*

2. The design process

In the design process, 14 sub-processes are identified, see also Figure 5. Essentially, six artifacts are designed, verified and validated in this process: 1) one or more decision(s), 2) a derivation structure, 3) a fact-type model, 4) business rules, 5) one or more decision design(s), and 6) a scope design. With regards to the first four artifacts, three sub-processes can be identified: define the artifact, see sub-process 2.1, 2.4, 2.7, and 2.10, verify the artifact, see sub-process 2.2, 2.5, 2.8, and 2.11, and validate the artifact, see sub-process 2.3, 2.6, 2.9, and 2.12.
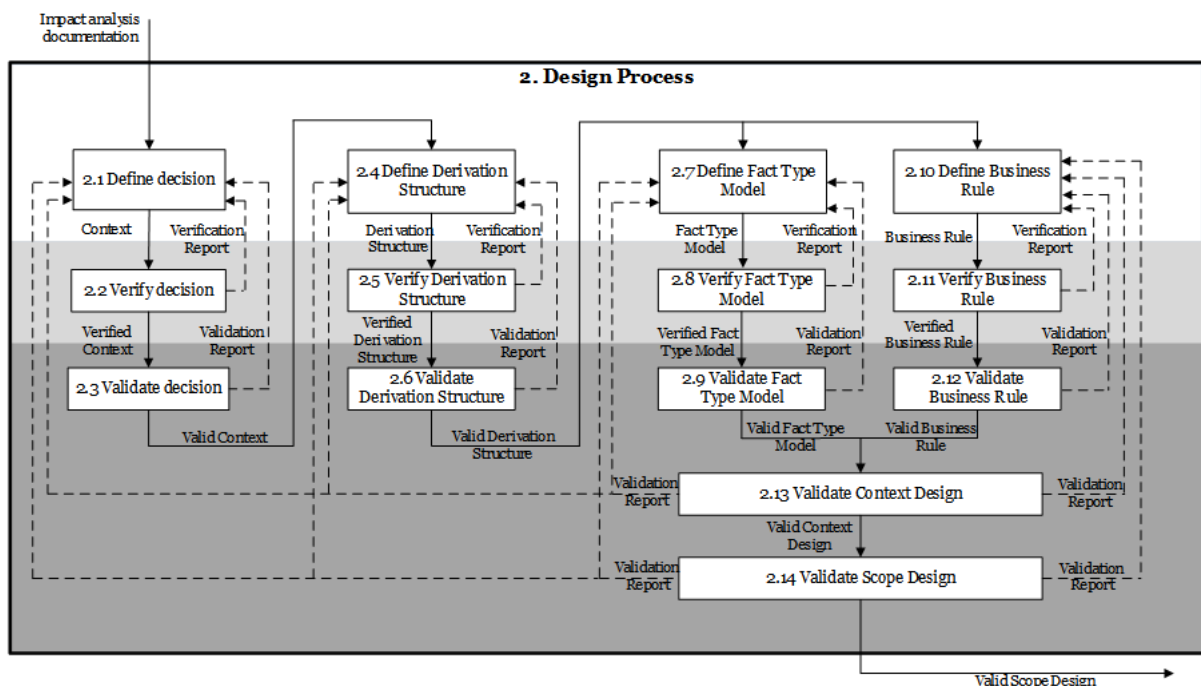

Figure 5. Detailed view of the *2. Design process*

The purpose of verification is to determine if the artifact adheres to predefined criteria and are logically consistent (to check for semantic / syntax errors). The purpose of validation is to determine whether the verified artifact holds to its intended behavior (to check for errors in its intended behavior). The goal of the sub-processes 2.1, 2.2, and 2.3 is to create a verified and validated decision. When more decisions are defined, the derivation structure needs to be defined, verified and validated in sub-processes 2.4, 2.5, and 2.6. The goal of a derivation structure is to depict the relationship between different decisions. After the decisions and derivation structure are both verified and validated, the fact-type model, in sub-processes 2.7, 2.8, and 2.9, and business rules, in sub-processes 2.10, 2.11, and 2.12 are created, verified and validated. The purpose of a fact-type model is to have a central repository in which terms, the relationship between these terms, and their definitions for a particular scope are recorded. Terms are used as conditions or conclusions in business rules. Lastly, the sum of all the artifacts in the individual decisions, see sub-process 2.13, and the scope, see sub-process 2.14, are validated once again to ensure all the artifacts combined in both a decision as well as a scope hold to their intended behavior. The output of the design process encompasses the valid scope design, which is the input for the subsequent process, the acceptation process.

3.   *The acceptation process*

The acceptation process consists of a transition between different roles for the sake of segregation of duties. The purpose of the acceptation process is to hand over the scope design to the role(s) responsible for the deployment of the business decisions and business logic. In this process, the role(s) responsible for the deployment have the responsibility to accept or reject the scope design. When the latter one happens, feedback is provided, and the process re-iterates back to either the elicitation or design process.

4.   *The deployment process*

The deployment process is a process in which the accepted implementation-independent scope design is transformed into one or multiple implementation-dependent variant(s). This process can be performed either manually as well as automatically, depending on the actual implementation of the business decision and business logic. A business decision or business logic can be represented by code in an information system, but also as, for example, documentation (i.e. work instructions), websites, manuals, and physical letters.

5.   *The execution process*

The execution process focuses on the execution of the implemented implementation-dependent scope design with the goal to realize the business decisions and business logic as grounded in the requirements submitted by clients. For example, the business decisions and business logic of the scope design '*determine amount of child benefits*' could be represented by the actual e-portal where citizens apply for child benefits, the notifications for or communication with citizens regarding the outcome of the decision, and documentation of the business logic implemented and used in the information system(s).

6.   *The governance process*

The governance process consists of validity management, traceability management, and version management. The goal of the governance process is to manage all occurrences from implementation-independent and implementation-dependent artifacts as well as manage the relationship between different artifacts to ensure modifications can be processed. As can been observed, the governance process is positioned along process 1, 2, 3, 4, and 5. Governance, in terms of validity management, traceability management, and version management, is required from the moment a requirement is received from a client as, usually, a lot of artefacts and re-iterations regarding those artefacts are instantiated to execute the business decisions and business logic, see also the work of (Smit & Zoet, 2016). Firstly, the goal of validity management is to be able to provide, at any given time, a specific version of business decisions and business logic that is/was valid at that point of time. Different versions of business decisions and business logic could be valid at the same point in time, see also the work of Boer, Winkels, van Engers, & de Maat (2004). Secondly, the goal of traceability management is to make it possible to trace created artifacts, as parts of business decisions and business logic, to the corresponding laws and regulations on which they are based. Another goal of traceability management is the foundation it forms for impact analysis when new or existing laws and regulations need to be processed into the value proposition. To create a feedback loop with the client that submits requirements, traceability is of importance as it enables the governmental agency to effectively and efficiently analyze the impact a requirement has on the currently implemented business decisions and business logic. Another benefit of traceability is that it enables the demonstration of the legality of the business decisions and business logic towards all stakeholders. Thirdly, the goal of version management is to capture and keep track of version data regarding the artifacts created or modified in the elicitation, design, verification, validation, deployment and execution processes.

7.   *The evaluation process*

In the evaluation process, three sub-processes are identified: *7.1 record data, 7.2 extract data, and 7.3 report key performance indicator,* see Figure 6. The overall goal of the evaluation process is to manage the quality of all the processes and sub-processes in the reference process. The goal of sub-process 7.1 is to actually store the data from the different processes in the reference process. When data is stored properly, sub-process 7.2 can be instantiated. The goal of sub-process 7.2 is to decompose and structure the stored data so that it can be used for reporting in sub-process 7.3. Lastly, sub-process 7.3 can be instantiated, which results in reported information that is used to control the processes in the reference process, see also the work of (Smit & Zoet, 2016) on a management control system for BRM. An example of a KPI that can be reported on with regards to this sub-process is: "*The frequency of executions of an implementation dependent business rule*" (Smit & Zoet, 2016).
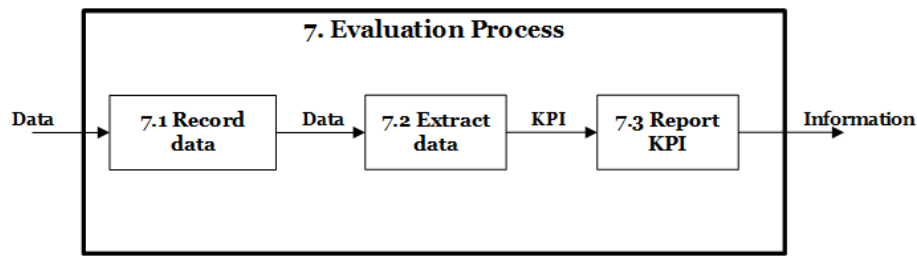
Figure 6. Detailed view of the *7. Evaluation process*

Overview of currently applied BRM processes

Further summarized, our findings show design decisions by the case organizations regarding their currently applied BRM processes. First, the results show that the validation capability, but mainly the verification capability are often not included as part of the BRM processes or are included in an implicit manner. The same holds for the acceptation process which is only explicitly applied by two case organizations. Lastly, none of the participated organizations apply any form of monitoring as part of their BRM processes, see also Table 1. In this overview, 'Ex' denotes that the activity is explicitly applied by the organization, 'Im' denotes that the activity is implicitly applied by the organization, and a blank cell denotes no explicit nor implicit application of the activity by the organization.

BRM reference process Activity	A	B	C	D	E
1.1 Determine scope	Ex	Im	Im	Ex	Im
1.2 Identify source	Ex	Im	Im	Im	Ex
1.3 Conduct impact analysis	Ex	Ex	Ex	Ex	Ex
2.1 Define decision	Im	Im		Ex	Im
2.2 Verify decision				Im	
2.3 Validate decision				Ex	
2.4 Define derivation structure	Im	Ex	Im	Ex	Ex
2.5 Verify derivation structure		Im	Im	Im	Im
2.6 Validate derivation structure		Im	Im	Ex	Ex
2.7 Define fact type model		Ex			Ex
2.8 Verify fact type model		Im			Im
2.9 Validate fact type model		Im			Ex
2.10 Define business rules	Ex	Ex	Ex	Ex	Ex
2.11 Verify business rules	Im	Im	Ex	Im	Im
2.12 Validate business rules	Im	Im	Ex	Ex	Ex
2.13 Validate scope design		Im	Im		
2.14 Validate scope design	Im			Im	Im
3. Acceptation process	Ex		Ex		
4. Deployment process	Ex	Ex	Ex	Ex	Ex
5. Execution process	Ex	Ex	Ex	Ex	Ex
6. Governance process	Im	Im	Im	Im	Im
7.1 Record data					
7.2 Extract data					
7.3 Report key performance indicator					

Table 1. Comparison of current BRM processes

Conclusion and discussion

To conclude our paper we revisit the goal of this research, which is to investigate the current BRM processes at Dutch governmental institutions to derive a BRM reference process for the Dutch government. To fulfill this goal, we aimed to find an answer to the following research question: "*Which (sub-)processes constitute a Business Rules Management process for the Dutch governmental agencies?*"

In this study, we designed and applied a research approach comprising five individual case studies and a three round focus group. Both research methods were applied to retrieve the BRM (sub-)processes and artifacts as building blocks for the BRM reference process for the Dutch government. In total, 31 participants were involved, which are employed by five governmental agencies in the Netherlands. Our rounds of data collection and analysis resulted in a BRM reference process that can be utilized by Dutch governmental organizations to guide their design and instantiation of their context-specific BRM processes as it embodies a proven template solution for a process for a particular domain, in this case, the application of BRM by governmental agencies. From a research perspective, our study provides a fundament for BRM processes in general, but also provides the knowledge base with an instanced BRM reference process within a governmental context. From a practical perspective, governmental institutions could utilize the results of this study to guide the (re)design of their BRM processes, but equally important, use the reference process to evolve towards a more collaborative mode in which a common vocabulary is developed with the goal to increase commonality. Eventually, more qualitative cooperation between governmental institutions could result in higher quality products and services for citizens and businesses in the Netherlands. Another benefit of this study that was mentioned repeatedly by the participants is the cooperation it facilitated between the different governmental agencies and their employees with regards to BRM.

In contrast, several limitations are applicable to this study, which may affect our results. As the sample group of case organizations and participants is solely drawn from the Dutch government context, our results are limited to be applied in this particular context as well. We argue that government agencies are representative for organizations implementing BRM solutions in general. Regarding this, we strongly suggest that future research should focus on; 1) the investigation of other industries with regards to BRM reference processes and 2) analysis of the amount of similarity or distance between the different BRM reference processes concerning different industries. Also, the sample size of 31 subject-matter experts could be seen as a limitation of this study. Although the research approach chosen for this research type is appropriate, future research should also focus on even stronger validation of the results of this study in the context of the Dutch government, i.e. by applying more quantitative research methods to increase the sample size. This is also grounded by the fact that there are more governmental agencies in the Netherlands that apply BRM, as well as different governmental institutions other that the executive branches, such as central government agencies, province agencies, municipalities, and high councils (i.e. the national audit office).

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