Solving Problems by Implementing a Business Rules Management System

A case study towards identifying design problems in Business Rules Management Systems

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Abstract— **During the timespan of the implementation of a system, the why and what against the actual state of the system can change. This difference is referred to as the design problem. Currently, no design problems are identified in Business Rules Management (BRM) and Business Rules Management System (BRMS) literature. To solve problems with a BRMS implementation it is important that the problems solved by this implementation are known, which is not the case. A case study approach is utilized containing two phases of data collection. Phase one consisted of multiple expert interviews focused on creating a set of design problems utilizing existing literature on BRMS design problems. Then, in phase two, the set of design problems were proposed to a selection of thirteen organizations, which indicated if the design problems occurred in a BRMS implementation. This resulted in a set of 24 design problems. The identification of design problems contributes to future research in evaluating BRMS's. Furthermore, the identification of design problems is a contribution towards situational artifact construction in the field of BRM.**

Keywords-Business Rules; Business Rules Management; Business Rules Management System; Design Problems.

I. INTRODUCTION

Organizations aim for a shorter time to market and lowering the cost of developing and maintaining any information systems to support their operations. Business Rules Management (BRM) technologies play an important role in organizations daily operations [1]–[3]. BRM is defined as: "*a systematic, and controlled approach to get a grip on business decisions and business logic to support the Elicitation, Design, Specification, Verification, Validation, Deployment, Execution, Governance, and Monitoring of both business decisions and business logic.*"[4]. Organizations have or could implement a system to support BRM. This is known as a Business Rules Management System (BRMS), which is defined as: "*a set of software components for the Elicitation, Design, Specification, Verification, Validation, Deployment, Execution, Monitoring, and Governance of business rules*"[5].

An increasing amount of BRMS implementations are executed nowadays, of which many are characterized by complications. The fundamental principle of creating and implementing an artifact is that having an understanding of a design problem and its solution (the capabilities of a BRMS [5]) are acquired in the building and application of an artifact (the BRMS) [6]. Therefore, the problem arises that no design problems are identified in the BRM research field. Compared to neighboring research fields, for example, Business Process Management [7], Software Product Management [8] and Enterprise Architecture [9], were the design problems are identified in detail. To explore the design problems related to BRM, an answer is required on the following research question: *Which design problems can be identified regarding the implementation of a Business Rules Management System?*

The goal of this study is to identify design problems which can be solved by implementing a BRMS. The identification of design problems creates a possibility for organizations to better clarify what problems they have and thereby what solution (e.g., a BRMS) is needed to solve these problems. The identification of design problems can be utilized for situational artifact construction. This technique requires the identification of design problems and uses these design problems to create BRMS instantiations for organizations with different specifics [10][11], for example, government agencies or insurance companies.

The structure of the paper is as follows: First, the context of this study, i.e., business rules, BRM, BRMS, and design problems are addressed. Second, the research method used to identify design problems which are solved by implementing a BRMS are discussed. Next, the data collection and analysis of this research regarding case study research is explained. Subsequently, the results which led to the set of design problems are elaborated. Finally, the conclusions that can be drawn from the results of this research, together with a critical view on the limitations of this research and possible future research possibilities are discussed.

II. RELATED WORK

Business rules describe the state of affairs of what the business demands [3] and the use in business and technology models [12]. A business rule is defined as: "*a statement that defines or constrains some aspect of the business intending to assert business structure or to control the behavior of the business*" [3]. For organizations to be in control of their business rules, an approach is utilized, which is known as BRM. BRM is an approach which contributes to the improved productivity or effectiveness of a Business Rules Management System. Each capability of the BRMS has its own goals and aims to increase the effectiveness and productivity of the BRM activities. The benefits of implementing a BRMS can be translated into design problems. For example, a BRMS is implemented to solve Elicitation productivity problems). In current BRM literature, benefits and advantages of using a BRMS are described in the work of [1]–[3], [13]–[16].

Design problems occurring in organizations are generally defined as "*the differences between a goal state and the current state of a system*" [6].

In the context of this study, this would mean that the current state is not having a BRMS implemented, and the goal state, an implemented BRMS. A specific configuration of the capabilities of a BRMS solve specific problems, the design problems, as demonstrated in Figure 1.
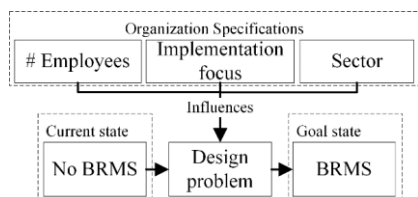

Figure 1. Design Problem Context

Research field maturity can be classified as nascent, intermediate and mature [17]. At the moment, the state of the BRM research field is nascent [16]. Therefore, research from neighboring fields on the identification of design problems is taken into consideration [7]–[9].

III. RESEARCH METHOD

The goal of this research is to identify design problems which occur when organizations implement a BRMS. To reach this goal, design problems which are encountered when implementing a BRMS should be identified. Therefore, a qualitative research approach is the most appropriate research methodology. Case study research is selected so the researchers could gather design problems in a specific context. This all leads towards the explorative nature of the case studies. The organizations included in the case study are distributed over the financial and public sector in the Netherlands. The researchers believe that the organizations from the public and financial sector are representative towards recognizing design problems in BRMS

implementations because of their extensive experience with rules, laws, regulations, and compliance. This research includes a holistic case study approach [18], consisting of several reasons of why an organization should implement a BRMS (context), thirteen organizations which implemented a BRMS within the context (cases), and the BRMS design problems (unit of analysis). The data collection consisted of two phases. Phase one is characterized by a combination of first degree and third-degree data collection techniques [19]. The third-degree data collection focused on gathering existing literature on design problems which occur when organizations implement a BRMS. The literature is mainly used to show the existence of benefits and advantages of using a BRMS. The first-degree data collection focused on experts validating the completeness of the set of design problems through expert interviews. Phase two is characterized as a first-degree data collection technique using expert interviews to state which design problem occurred during their BRMS implementation [19].

IV. DATA COLLECTION AND ANALYSIS

Phase one data collection was completed in November 2016. The literature study was focused on identifying the existence of benefits and advantages of implementing a BRMS. The studied literature was used as an indication of the existence of advantages and benefits of which occur when utilizing a BRMS (as shown in Figure 2).
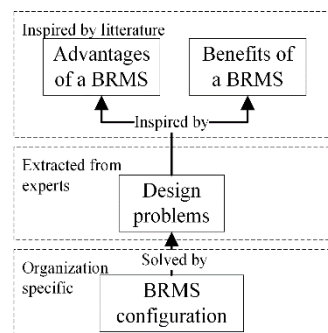

Figure 2. Collection Of Design Problems

These were translated into a set of 24 design problems. The 24 design problems were validated through expert interviews. These expert interviews focused on validating the existence of the design problems and the completeness of the set of design problems derived from literature. Four expert interviews were conducted with an average duration of one hour. Each design problem was proposed to experts and input was asked about whether these were relevant in practice and if the design problem was complete enough to describe the spectrum of design problems that can be solved by implementing a BRMS. The four experts had the following backgrounds: expert 1: a professor with eight years of practical and research experience in the field of BRM and BRMS; expert 2: a lecturer and PhD-candidate with five years of practical and research experience in the field of BRM and

BRMS; expert 3: a Master student with four years of practical and research experience on BRMS capabilities, and expert 4: a BRM and BRMS practitioner with 21 years of experience on multiple BRM and BRMS implementations.

Phase two data collection is completed during a period of four months, between January 2017 and April 2017, through a case study at 13 organizations. The organizations requested that their data is handled anonymously. Therefore, ID's are added ranging from 1 to 13. Participants of this research are selected based on their knowledge towards the studied phenomenon, which are: the group of individuals, organizations, information technology, or community [20]. Translated to this research, the studied phenomenon is represented by organizations and individuals within these specific organizations which deal or that dealt with the implementation of a BRMS. Therefore, are knowledgeable on *why* and *how* a BRMS is implemented. The organizations included in this case study are distributed over the Dutch financial and public sector. These two sectors are selected due to the fact that these organizations have many products and services that are (semi) digitally handled in combination with high numbers of applications. This ensures that large parts of their products and services use business rules. To characterize the 13 organizations, certain situational factors are identified at each organization to create an overview as shown in Table I. The 24 design problems (from phase 1) were proposed, separately, to the participants, thereby creating a list of the occurrences of the known 24 design problems at the thirteen organizations.

TABLE I. CASE STUDY ORGANIZATIONS

Case ID:	Sector:	Employees:	Implementation focus:
1	Public	2001 - 5000	Organization-wide
2	Public	2001 - 5000	Organization-wide
3	Public	>5000	Application focused
4	Public	2001 - 5000	Organization-wide
5	Financial	2001 - 5000	Application focused
6	Financial	2001 - 5000	Line of business focused
7	Financial	501 - 1000	Line of business focused
8	Financial	251 - 500	Line of business focused
9	Financial	>5000	Organization-wide
10	Public	251 - 500	Application focused
11	Public	>5000	Line of business focused
12	Financial	501 - 1000	Organization-wide
13	Public	2001 - 5000	Organization-wide

The employee range of the organizations is identified as a situational factor. These employee ranges could influence different implementation setups. For example, Organization 1, with 2001 - 5000 employees possibly need a different configuration of BRMS capabilities compared to Organization 10 with 251 - 500 employees. The employee ranges are adopted from previously conducted research where

design problems are also a topic of research [10][11]. Three main implementation scopes can be identified, which are: Application focused, Line of Business focused and Organization-wide. The work of Nelson et al., [21] demonstrated the scoping from narrow (single application focused) and expanded to Line of Business focused and eventually to Organization-wide. The implementation focus intends to characterize the aim of each separate type of implementation.

V. RESULTS

Phase one and phase two of the data collection resulted in a set of 24 design problems and are validated (on occurrence) by thirteen organizations. The organizations were asked if they recognized one of the design problems as a design problem in their BRMS implementations. The 24 design problems are listed in Table II.

TABLE II. DESIGN PROBLEMS

Design problem #:	Design problem name:
1	Increase Elicitation productivity
2	Increase Elicitation effectiveness
3	Construct library of decisions
4	Ensure artifact relationship insight
5	Reduce Design effort
6	Shortening the Design phase
7	Increase Design productivity
8	Increase Design effectiveness
9	Support experts mobilization
10	Mapping of business rules
11	Improve Validation and Verification quality
12	Ensure automated Verification
13	Reduce Verification effort
14	Increase Verification productivity
15	Increase Verification effectiveness
16	Ensure automated test cases generation
17	Ensure automated Validation testing
18	Perform impact analysis
19	Create validated and accessible business rules
20	Reduce testing for implementation independent and dependent models
21	Reduce Validation effort
22	Ensure working with implementation independent business rules to export models
23	Simplify models into code
24	Separate 'know' and 'flow'

The occurrence of the 24 design problems (DP#) during the BRMS implementations at the 13 organizations is questioned, and this resulted in an occurrence percentage for each design problem together with a description, as shown down below. Most of the design problems affect a BRM capability (Elicitation, Design, Specification, Verification, Validation,

Deployment, Execution, Monitoring, and Governance). These BRM capabilities are explained, in detail, in the work of Smit and Zoet [5].

Design problem 1: Increase Elicitation productivity

DP1 requires a specific configuration of a BRMS to increase the productivity of the Elicitation capability. For example, an implemented BRMS facilitates employees working on Elicitation with the possibility of supporting the comparison of different elicitation sources. 46.15% of the organizations identified this as a known design problem.

Design problem 2: Increase Elicitation effectiveness

DP2 requires a BRMS configuration to increase the effectiveness of the Elicitation capability. For example, an implemented BRMS facilitates the stakeholders of Elicitation with the possibility of automatizing annotations of sources. 76.92% of the organizations identified this as a design problem in their context.

Design problem 3: Construct library of decisions

DP3 requires a BRMS configuration to solve the problem of constructing a library of decisions. For example, an implemented BRMS supports the creation of a library of decisions on one central location. 61.54% of the organizations identified this as a design problem in their context.

Design problem 4: Ensure artifact relationship insight

DP4 requires a BRMS configuration to give insight into relationships between artifacts. For example, an implemented BRMS provides the stakeholders with an estimation of the impact of a to be made term change. 76.92% of the organizations identified this as a design problem in their context.

Design problem 5: Reduce Design effort

DP5 requires a BRMS configuration to reduce the effort needed in the Design capability, specific for the requirements and specifications. For example, an implemented BRMS creates the possibility for the stakeholders of Design to support them by selecting the right rule base automatically. 69.23% of the organizations identified this as a design problem in their context.

Design problem 6: Shortening the Design phase

DP6 requires a BRMS configuration to shorten the Design phase of BRM. For example, an implemented BRMS enables the reuse of decision structures or decisions. 69.23% of the organizations identified this as a design problem in their context.

Design problem 7: Increase Design productivity

DP7 requires a BRMS configuration to increase the productivity of the Design capability. For example, an implemented BRMS reuses patterns by filtering the rule base

elements on features, such as type, status, version, and validity. 76.92% of the organizations identified this as a design problem in their context.

Design problem 8: Increase Design effectiveness

DP8 requires a BRMS configuration increase the effectiveness of the Design capability. For example, an implemented BRMS facilitates the stakeholders of Design with the possibility of automatizing the creation of diagrams. 92.31% of the organizations identified this as a design problem in their context.

Design problem 9: Support experts mobilization

DP9 requires a BRMS configuration to support the mobilization of experts involved in the BRM process. For example, an implemented BRMS supports printing reports in a specific format to be used by the involved experts. 69.23% of the organizations identified this as a design problem in their context.

Design problem 10: Mapping of business rules

DP10 requires a BRMS configuration to facilitate the mapping of business rules. For example, an implemented BRMS creates the possibility to link decisions by modeling them together visually. 76.92% of the organizations identified this as a design problem in their context.

Design problem 11: Ensure Validation and Verification quality

DP11 requires a BRMS configuration to ensure the quality assurance of the Validation and Verification capabilities. For example, an implemented BRMS ensures the securing of the quality of Validation and Verification by generating a report. 84.62% of the organizations identified this as a design problem in their context.

Design problem 12: Ensure automated Verification

DP12 requires a BRMS configuration to ensure the automated Verification of business rules. For example, an implemented BRMS ensures automated Verification of redundancy and lexical errors. 61.54% of the organizations identified this as a design problem in their context.

Design problem 13: Reduce Verification effort

DP13 requires a BRMS configuration to reduce the effort needed in the Verification capability. For example, an implemented BRMS creates the possibility for the stakeholders of Verification to suggest repair options. 46.15% of the organizations identified this as a design problem in their context.

Design problem 14: Increase Verification productivity

DP14 requires a BRMS configuration to increase the productivity of the Verification capability. For example, an implemented BRMS facilitates the stakeholders of

Verification by filtering and sorting reports to execute a specific check. 53.85% of the organizations identified this as a design problem in their context.

Design problem 15: Increase Verification effectiveness

DP15 requires a BRMS configuration to increase the effectiveness of the Verification capability. For example, an implemented BRMS facilitates the stakeholders of Verification by displaying the conclusions of other colleagues to check for inconsistencies. 61.54% of the organizations identified this as a design problem in their context.

Design problem 16: Ensure automated test cases generation

DP16 requires a BRMS configuration to create the possibility for the generation of automated test cases in the Validation capability. For example, based on fact types and fact values within the context of scenarios, a number of combinations are tested. 46.15% of the organizations identified this as a design problem in their context.

Design problem 17: Ensure automated Validation testing

DP17 requires a BRMS configuration to perform automated testing in the Validation capability. For example, an implemented BRMS supports the creation of generated test cases to be used for the automated Validation testing. 46.15% of the organizations identified this as a design problem in their context.

Design problem 18: Perform impact analysis

DP18 requires a BRMS configuration to give insight which artifacts are hit when a change is performed. For example, an implemented BRMS gives an overview of the impact of a law change which affects related terms. 69.23% of the organizations identified this as a design problem in their context.

Design problem 19: Create validated and accessible business rules

DP19 requires a BRMS configuration to provide validated and accessible business rules. For example, an implemented BRMS implementation generates a validation report. 84.62% of the organizations identified this as a design problem in their context.

Design problem 20: Reduce testing for implementation independent and dependent models

DP 20 requires a BRMS configuration to reduce the testing of implementation independent models (models not specified to a specific context) and implementation-dependent models (models specified to a specific context). 30.77% of the organizations identified this as a design problem in their context.

Design problem 21: Reduce Validation effort

DP21 requires a BRMS configuration to reduce the effort needed in the Validation capability. For example, an implemented BRMS automatically determines the input and output variables when testing. 53.85% of the organizations identified this as a design problem in their context.

Design problem 22: Ensure working with implementation independent business rules to export models

DP22 requires a BRMS configuration to ensures for implementation independent business rules to export models. For example, an implemented BRMS ensures implementation independent business rules to export models (e.g., Decision Modeling Notation (DMN)). 38.46% of the organizations identified this as a design problem in their context.

Design problem 23: Simplify models into code

DP23 requires a BRMS implementation to simplify converting from models to code. For example, DMN into java code. 61.54% of the organizations identified this as a design problem in their context.

Design problem 24: Separate 'know' and 'flow'

DP24 requires a BRMS configuration to separate the implementation of the 'know' and the 'flow'. For example, an implemented BRMS separates the business logic, business rules, concepts and relations from the business process. 69.23% of the organizations identified this as a design problem in their context.

VI. DISCUSSION AND CONCLUSIONS

The goal of this research is to identify BRMS design problems. To achieve this, the following research question is answered: *''Which design problems can be identified regarding the implementation of a Business Rules Management System?''* In order to identify BRMS design problems, the researchers utilized a case study approach and conducted two phases of data collection. Phase one, aimed at existing literature on advantages and benefits of a BRMS and experts validating the completeness and relatability of the gathered design problems. Phase two focused on validating the set of design problems at thirteen organizations with BRMS implementations. From a research perspective, this research provides a basis upon which future identification of design problems in the field of BRM of related fields can be built. Furthermore, the identification of design problems is a key element for conducting situational artifact construction, due to the fact that situational artifacts are created to solve specific problems, design problems [10]. Therefore, this research contributes towards future situational artifact construction in the BRM domain. From a practical point of view, organizations could benefit from the identified design problems because it provides them with explicit design problems which can be solved by implementing a BRMS. Additionally, organizations can compare problems by using the set of design problems as a reference to their own design

problems. Furthermore, the results of this study are used to create a substantiated business case.

Several limitations may affect the results of this research. The first limitation is the sampling technique. The case only existed of organizations drawn from the public and financial sector. We believe that the organizations from the public and financial sector are representative towards recognizing design problems in BRMS implementations. Further increasing the sample including industries other than public and financial organizations is required. The second limitation is that of the lack of any nominal comparison. Additional nominal comparison could be conducted to indicate the importance of identified elements, which design problem affects the implementation of a BRMS [22]. Being that a design problem is a problem (1) or not a problem (0), compared to that of situational factors [16] where there the organizations cannot select their situational factors.

Following these limitations, we believe that future research should incorporate organizations from other industries, to compare occurrences of design problems between sectors. Furthermore, the next recommended step would be using this set of design problems in the context of situational artifact construction in the BRM domain.

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