Performance Indicators for Business Rule Management

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***Abstract*— With increasing investments in business rules management (BRM), organizations are searching for ways to value and benchmark their processes to elicitate, design, accept, deploy and execute business rules. To realize valuation and benchmarking of previously mentioned processes, organizations must be aware that performance measurement is essential, and of equal importance, which performance indicators to apply to the performance measurement processes. However, scientific research on BRM, in general, is limited and research that focuses on BRM in combination with performance indicators is nascent. The purpose of this paper is to define performance indicators for previously mentioned BRM processes. We conducted a three round focus group and three round Delphi Study which led to the identification of 14 performance indicators. Presented results provide a grounded basis from which further, empirical, research on performance indicators for BRM can be explored.**

Keywords-Business Rules Management; Business Rules; Performance Measurement; Performance Indicator.

I. INTRODUCTION

Business rules are an important part of an organization's daily activities. Many business services nowadays rely heavily on business rules to express assessments, predictions and decisions [2][15]. A business rule is [11] "*a statement that defines or constrains some aspect of the business intending to assert business structure or to control the behavior of the business.*" Most organizations experience three challenges when dealing with business rules management: 1) consistency challenges, 2) impact analysis challenges, and 3) transparency of business rule execution. A consistent interpretation of business rules ensures that different actors apply the same business rules, and apply them consistently. This is a challenge since business rules are often not centralized, but they are embedded in various elements of an organization's information system instead. For example, business rules are embedded in minds of employees, part of textual procedures, manuals, tables, schemes, business process models, and hard-coded as software applications. Impact assessment determines the impact of changes made to business rules and the effect on an existing implementation. Currently, impact assessments can take significant time which results in situations where the business rules already have changed again while the impact assessment is still ongoing [1]. Transparency, or business rules transparency, indicates that organizations should establish a system to prove which business rules are applied at a specific moment in time. To tackle the previously mentioned challenges and to improve grip on business rules, organizations search for a systematic and controlled approach to support the discovery, design, validation and deployment of business rules [2][21]. To be able to manage or even address these challenges, insight has to be created concerning business rule management processes at organizations. This can be achieved using performance management, which can provide insight into an organization's current situation, but can also point towards where and how to improve. However, research on performance management concerning BRM is nascent.

The measurement of performance has always been important in the field of enterprise management and, therefore, has been of interest for both practitioners and researchers. Performance systems are applied to provide useful information to manage, control and improve business processes. One of the most important tasks of a performance management system is to identify (and properly) evaluate suitable Performance Indicators (PI's). The increase of interest and research towards identifying the right set of indicators has led to 'standard' frameworks and PI's tailored to industry or purpose. Examples of such frameworks are the balanced scorecard, total quality management framework, and seven-S model [9][18]. Moreover, research on standard indicators is increasingly performed for the sales and manufacturing processes. To the knowledge of the authors, research which focuses on performance measures for BRM is absent. This article extends the understanding of performance measurement with regard to the BRM processes. To be able to do so, the following research question is addressed: "*Which performance indicators are useful to measure the BRM processes?"*

This paper is organized as follows: In section two we provide insights into PI's and BRM. This is followed by a description of the research method used to construct our artifact in section three. Furthermore, the analysis of our research results is described in section four. Subsequently, our results which led to our Performance Indicators for BRM are presented section five. Finally, in section six we discuss which

 ISBN: 978-1-61208-472-5

conclusions can be drawn from our results, followed by a critical view of the research method and results of our study.

II. RELATED WORK AND BACKGROUND

The aim of using a performance measurement system is to provide a closed loop control system in line with predefined business objectives. In scientific literature and industry, an abundance of performance management systems exists [6]. Although a lot of performance systems exist, in general, they can be grouped into four base types [9]: 1) consolidate and simulate, 2) consolidate and manage, 3) innovate and stimulate, and 4) innovate and manage. The predefined business objectives, and, therefore, the creation of the closed loop control system, differ per base-type. In the remainder of this section, first the four performance measurement system base-types will be discussed after which the registration of a single performance measure will be presented. Subsequently, the processes will be discussed for which the performance management system is created. The last paragraph will focus on bringing all elements together.

Performance measurement systems of the first base-type, *consolidate and stimulate*, are utilized to measure and stimulate the current system performance. The formulation process of PI's is usually performed with employees that work with the system, possibly in combination with direct management, and is, therefore, a bottom-up approach. Examples of this type of performance measurement system are the "control loop system" or "business process management system". Performance measurement systems, that focus purely on measuring and maintaining the current performance level, are classified as the second base-type c*onsolidate and manage.* Consolidate and manage is a purely top-down approach in which PI's are formulated by top management based on the current strategy. Each PI defined by the top-management is translated into multiple different underlying PI's by each lower management level. Two examples of performance measurement systems of this type are "management by objectives" and "quality policy development".

The third base-type, *innovate and stimulate*, focuses on the customer and the product or service delivered to the customer by the organization. To define the PI's, first the quality attributes of the product or service delivered to the customer need to be defined. Based on these quality attributes, PI's for each business process that contributes to the product or service is defined. An example of a performance measurement system of this type is Quality Function Deployment (QFD). The fourth base-type, *innovate and manage*, focuses on the future of the organization while managing the present. It is a top-down approach in which PI's are formulated, based on the strategy of the organization. Furthermore, these PI's are then translated to the lower echelons of the organization. Furthermore, PI's that are used to manage the current state of the organization are specified. The combination of both measures is used to make sure that the company is performing well while at the same time steering it into the future. An example of this performance measurement system type is the Balanced Score Card.

In addition to choosing the (combination of) performance measurement system(s), the individual performance indicators (PI's) of which the performance measurement system is composed have to be defined. A PI is defined as: "*an authoritative measure, often in quantitative form, of one or multiple aspects of the organizational system."* Scholars as well as practitioners debate on which characteristics must be registered with respect to PI's [8][14]. Comparative research executed by [14] identified a set of five characteristics each scholar applies: 1) the PI must be derived from objectives, 2) the PI must be clearly defined with an explicit purpose, 3) the PI must be relevant and easy to maintain, 4) the PI must be simple to understand, and 5) the PI provide fast and accurate feedback.

The performance measurement system in this paper is developed for the elicitation, design, acceptation, deployment, and execution process of BRM. A detailed explanation of the BRM processes can be found in [23]. 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. Business rule sets can provide the following value propositions: classification, assessments, diagnosis, monitoring, prediction, configuration design, modelling, planning, scheduling, and assignment [3]. Before the business rule set can be executed, it first needs to be elicitated, designed, accepted, and deployed. The elicitation process exists out of two main tasks: determining the scope and identifying sources. In the task *determining 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 regulation. After the data sources have been determined the design process starts which consists of five phases. 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 adhere to the single responsibility principle [11]. The purpose of the context architecture is to create a normalized business rule set in which individual business rule set can be changed without affecting other parts. For example, the scope is "determine candidate profile" which can be composed into multiple business rule sets: "determine candidate personality rating", "determine candidate cognitive rating", and "candidate maturity rating." After the business rule architecture is created it is verified (to check for semantic / syntax errors) and validated (to check for errors in its intended behavior). 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

 ISBN: 978-1-61208-472-5

models have been modelled in an implementation-independent language. An implementation-independent language is considered as: "*a language that is not tailored to be applicable to a specific information system*" [23]. An implementation dependent language, on the other hand, is defined as: "*a language that is tailored to be applicable to a specific information system*" [23]. Implementation dependent business rule languages have a specific grammar which can only be interpreted by a specific system. Examples of such systems are [19] and [20]. 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.

BRM is a process that deals with the elicitation, design, acceptation, deployment, and execution process of business rules within an organization to support and improve its business performance. Organizations are realizing that business rules are crucial resources that should be managed to stay competitive and innovative. Since no absolute measurement exists to measure the success of BRM as whole as well as individual BRM processes in an organization, this research will focus on identifying PI's from the perspective of the first base-type, *consolidate and stimulate*. This implies that we will apply a bottom-up approach and will involve employees working on business rules and their direct management. Our focus per PI will be on the characteristics as defined by [8]: 1) derived from objectives, 2) clearly defined with an explicit purpose, 3) relevant and easy to maintain, 4) simple to understand, and 5) provide fast and accurate feedback.

III. Research Method

The goal of this research is to identify performance measurements that provide relevant insight into the performance of the elicitation, design, acceptation, deployment, and execution process of business rules. 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 none-technological research, is nascent [10][15][23]. Focus of research in nascent research fields should lie on identifying new constructs and establishing relationships between identified constructs [5]. Summarized, to accomplish our research goal, a research approach is needed in which a broad range of possible performance measurements are explored and combined into one view in order to contribute to an incomplete state of knowledge.

Adequate research methods to explore a broad range of possible ideas / solutions to a complex issue and combine them into one view when a lack of empirical evidence exists consist of group-based research techniques [4][13][16][17]. 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 the following two group based research approaches: the Focus Group and Delphi Study.

IV. 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: experts 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

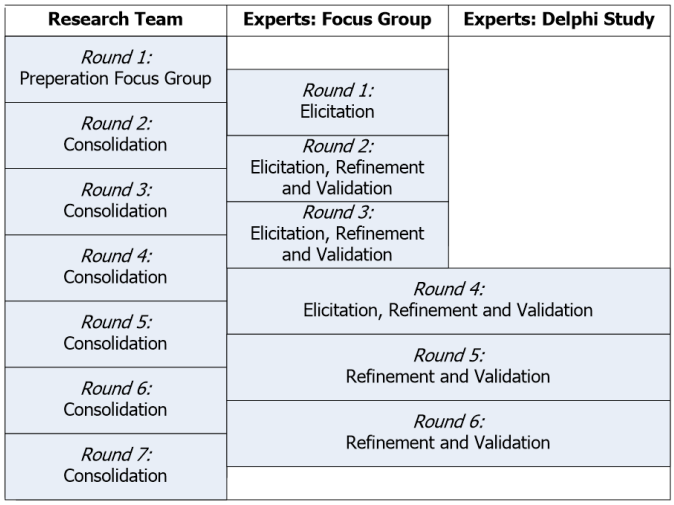

Figure 1. Data collection process design

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.

A. 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 performance measurements for the performance of the elicitation, design, acceptation, deployment, and execution process of business rules. The selection of the participants should be based on the group of individuals, organizations, information technology, or community that best represents the phenomenon studied [22]. 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, which was conducted from September 2014 to November 2014, five large 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, ten participants took part who fulfilled the following positions: two enterprise architects, two business rules architects, three business rules analysts, one project manager, and two policy advisors. Each of the participants had, at least, five years of experience with business rules. Delbecq and van de Ven [4] and Glaser [7] 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 7 years of research on the topic, and has facilitated many (similar) focus group meetings before. Besides the facilitator, 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 four researchers acted as a minute's secretary taking field notes. They did not intervene in the process; they operated from the sideline. All focus groups were video and audio recorded. A focus group meeting took on average three and a half hour. 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 submit their current PI's applied in the BRM process. When participants had submitted PI's, they had the opportunity to elaborate upon their PI's during the first focus group meeting. During this meeting, also, additional PI's were proposed. For each proposed PI, the name, goal, specification and measurements were discussed and noted. For some PI's, the participants did not know which specifications or measurements to use. These elements were left blank and agreed to deal with during the second focus group meeting. After the first focus group, the researchers consolidated the results. Consolidation comprised the detection of double PI's, incomplete PI's, conflicting goals and measurements. Double PI's exist in two forms: 1) identical PI's and 2) PI's which are textually different, but similar on the conceptual level. 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 PI's described correctly?", "2) Do I want to remove a PI?" 3) "Do we need additional PI's?", and 4) "How do the PI's affect the design of a business rule management solution?". 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). After the third focus group meeting (round 3), saturation within the group occurred leading to a consolidated set of PI's.

B. 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 PI's identified in the focus group meetings, and the second goal was to identify new PI's. Based on the written description of the goal and consultation with employees of each organization, participants were selected to take part in the Delphi study. In total, 36 participants took part. Twenty-six experts, in addition to the ten experts that participated in the focus group meetings, of the large Dutch government institutions were involved in the Delphi Study, which was conducted from November 2014 to December 2014. The reason for involving the ten experts from the focus groups was to decrease the likelihood of peer-pressure amongst group members. This is achieved by exploiting the advantage of a Delphi Study which is characterized by a non-face-to-face approach. The twenty-six additional participants involved in the Delphi Study had the following positions: three project managers, four enterprise architects, ten business rules analyst, five policy advisors, two IT-architects, six 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, whereby each participant was asked to assess the PI's in relationship to four questions: 1) "Are all PI's described correctly?", "2) Do I want to remove a PI?" 3) "Do we need additional PI's?", and 4) "How do the PI's affect the design of a BRM solution?"

V. RESULTS

In this section, the overall results of this study are presented. Furthermore, the final PI's are listed. Each PI is specified using a specific format to convey their characteristics in a unified way.

TABLE I. EXAMPLE OF PI RESULT: TIME MEASUREMENT TO DEFINE, VERIFY, AND VALIDATE A BUSINESS RULE.

PI 09: The amount of time units needed to define, verify, and validate a single business rule. **Goal**: Shortening the time needed to deliver defined, verified, and validated business rules.	
S	The number of time units per selected single business rule: • Measured over the entire collection of context designs; • During the design process; • (Sorted by selected context design); • (Sorted by selected complexity level of a business rule); • (Sorted by selected scope design); • (Sorted by selected time unit).
M	• Context design • Business rule • Complexity level of a business rule • Scope design • Time unit

Before the first focus group was conducted, participants were invited to submit the PI's they currently use. This resulted in the submission of zero PI's. Since this result can imply a multitude of things (e.g. total absence of the phenomena researched or unmotivated participants), further inquiry was conducted. The reason that no participants submitted PI's was because none of the participants had a formal performance measurement system in place. Some measured BRM processes but did so in an ad-hoc and unstructured manner. The first focus group meeting resulted in 24 PI's. This first focus group meeting also had one interesting side-discussion: can a PI be configured to monitor specific individuals? For example, "*the number of incorrectly written business rules per business rule analyst.*" Since the discussion became quite heated during the meeting, it was decided that each expert would think about and reflect on this question outside the group and that this discussion would be continued in the next focus group meeting.

After analyzing the results of the first focus group the 24 PI's were sent to the participants of the second focus group. During the second focus group, the participants started to discuss the usefulness of the PI's and the fact that too many PI's is also not a good thing. This resulted in the removal of ten conceptual PI's. Ten PI's were discarded because they did not add value to the performance measurement process concerning BRM. This resulted into 14 remaining PI's, which had to be further analyzed by the researchers. Also, the discussion about the PI's formulated to measure specific individuals was continued. At the end, only three experts thought this was reasonable and useful. The other seven disagreed and found it not useful which has led to the exclusion of PI's targeted at a specific individual.

During the third focus group, the participants discussed the remaining 14 final PI's which led to the further refinement of goals, specifications, and measurements. Additionally, the subject-matter experts expressed a certain need to categorize PI's into well-known phases within the development process of business rules at the case companies. From the 14 remaining PI's, nine PI's were categorized as business rule design PI's, two PI's were categorized as business rule deployment PI's, and three PI's were categorized as business rules execution PI's.

After the third focus group, the 14 PI's were subjected to the Delphi Study participants. In each of the three rounds, no additional PI's were formulated by the 26 experts. However, during the first two rounds, the specification and measurement elements of multiple PI's were refined. During the third round, which was also the last round, no further refinements were proposed and participants all agreed to the 14 formulated PI's which are presented in table 2.

TABLE II. PI'S DERIVED FOR BRM.

PI 01: The frequency of corrections per selected context design emerging from the verification process.
Goal: Improve upon the design process of business rules.

PI 02: The frequency of corrections per selected context design, emerging from the verification process, per business analyst and per type of verification error.
Goal: Improving the context design.

PI 03: The frequency of corrections per selected context design emerging from the validation process per complexity level of a business rule.
Goal: Improve upon the design process of business rules.

PI 04: The frequency of corrections per selected context design emerging from the validation process per type of validation error.
Goal: Improve upon the validation process for the benefit of improving the context design.

PI 05: The frequency of corrections per selected context architecture emerging from the design process per scope design.
Goal: Improve upon the design process for the benefit of improving the context architecture.

PI 06: The frequency of instantiations per selected context design
Goal: Provide insight into the possible instances of a context design.

PI 07: The frequency per selected type of validation error.
Goal: Improve upon the design process for the benefit of improving the context design.

PI 08: The frequency per selected type of verification error
Goal: Improve upon the design process for the benefit of improving the context design.

PI 09: The number of time units required to define, verify, and validate a single business rule.
Goal: Shortening the lead time of a business rule with regard to the design process.

PI 10: The frequency of deviations between an implementation dependent context design and an implementation independent context design.
Goal: Improve upon the deployment process.

PI 11: The frequency of executions of an implementation dependent business rule.
Goal: Gaining insight into which business rules are executed.

PI 12: The frequency of execution variants of a scope design.
Goal: Gaining insight into which decision paths are traversed to establish different decisions.

PI 13: The number of time units required for the execution per execution variant.
Goal: Shortening the lead time of an execution process with regard to enhancing an execution variant.

PI 14: The amount of business rules that cannot be automated.
Goal: Provide insight into which business rules cannot be automated.

Analyzing the defined PI's showed that three out of fourteen (PI 11, 12, and 14) are PI's that can be classified as *'innovate and manage'* PI's. PI eleven and twelve focus on the number of times a business rule is executed. Thereby providing insight in which business rules are most applied. PI twelve

goes beyond that and shows which variants of business rules are executed. In other words, it shows the characteristics of the decision based on which citizens get services. This insight can be used to determine how many and which citizens are affected by changing specific laws (and, therefore, business rules). In other words, this can be used to further support the development of law. PI fourteen indicated the amount of business rules that cannot be automated and that needs to be executed manually. This can also provide an indication of the amount of workload that organisations encounter due to the manual execution of these specific business rules. This PI can be used to decide if these business rules should be executed manually or that they should be reformulated in such a manner that they can be executed mechanically.

VI. DISCUSSION, CONCLUSION, AND FUTURE WORK

From a research perspective, our study provides a fundament for PI measurement and benchmarking of the elicitation, design, acceptance, deployment, and execution processes of BRM. 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. While we believe that government institutions are representative for organisations implementing business rules, further generalization towards non-governmental organizations amongst others is a recommended direction for future research. Taken the sample size of 36 participants into account, this number needs to be increased in future research as well. 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 given the present maturity of the research domain, research focusing on further generalization must apply different research methods such as qualitative research methods which also allow incorporating a larger sample size in future research regarding PI's for BRM.

This research investigated PI's for the elicitation, design, acceptance, deployment and execution of business rules with the purpose of answering the following research question: "*Which performance measurements are useful to measure the BRM processes?*" To accomplish this goal, we conducted a study combining a three round focus group and three round Delphi Study. Both were applied to retrieve PI's from participants, 36 in total, employed by governmental institutions. This analysis revealed fourteen PI's. We believe that this work represents a further step in research on PI's for BRM and maturing the BRM field as a whole.

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