Using Business Process Simulation to Assess the Effect of Business Rules Automation

Olga Levina
Department of Systems Analysis and IT
Berlin Institute of Technology
Olga.levina@sysedv.tu-berlin.de

Abstract-- Application of the business rules approach is often argued in research and practice to result in more efficient and enhanced processes. As the extent of this statement has yet to be shown, in this paper the process simulation method is applied to assess the effect of business rules externalization and automation on business process performance. A real-world decision and information intensive process is used here as a case study. Business process simulation is applied here to assess process performance difference between as-is and enhanced to-be process. Comparison of the obtained simulation results of the re-engineered to-be process that includes automated business rules and the as-is process indicate an increase of process performance measured in time and costs while attributing this effect to the automation of identified business rules.

Keywords- Business rules; business process management; business process simulation.

I. INTRODUCTION

This paper addresses the question put in [1] on how automation of business rules changes business process performance and extends its methodology by using a more extensive case study, multiple performance indicators and business process simulation.

Business process simulation has gained a lot of attention in the context of business process re-engineering in 1990ies as a tool to support managerial decision and illustrate potential effects of a newly designed business process without significant financial effort. Business process simulation aims at assisting the process of modeling and analyzing organizational structures. Use of simulation in the context of business process re-engineering is based on the approach to computer-aided analysis expressed by Simon [2]. He argues that one of the most important uses of computers is "to model complex situations and to infer the consequences of alternative decisions to overcome bounded human rationality". Being an operational research technique simulation has a major advantage as it allows experimentation with any element of a business system [3] being used in order to measure, understand and predict the metrics of process improvement and quality [4]. Thus, one of the major application areas for simulation is the exploration of effects introduced support by the information technology (IT) will have on the process performance (see e.g., [4]).

In this paper, the effect of business rules automation on defined process performance indicators is measured using a case study: a real-life business process of a health fund. Business rules automation implies rule identification, e.g., from software code or expert knowledge, their externalization, i.e., documentation and description in machine-readable format, and automated execution, i.e., enactment within a business rules management system or rule engine of a workflow management system. This research is based on the discussion in the area of business process management stating that IT-supported business rules management enables a better process management in terms of maintainability [5] as well as performance and efficiency [5]. Thus, the research question here is: can the impact of business rules automation on business process performance be captured and if yes, is this impact positive or negative on pre-defined business process indicators. The research method applied here is a case study-based simulation of a real-life business process. The effect of business rules automation is measured by comparing metrics from the as-is and to-be process that integrates business rules automation. This research method is used for artifact evaluation purposes in design science research [6] and business process re-engineering as well as hypothesis or theory testing in social sciences. Here it is applied in the area of assessment of business process automation and thus, re-engineering.

The remainder of the paper is structured as follows: first a short introduction into the business rules and business process management context is provided. In Section 3, a short overview of related work in business process management is given. Simulation experiment design as well as the case study process are described in Section 4. Section 5 provides an overview and discussion of the simulation results. Conclusion and outlook finish the paper.

II. BUSINESS RULES AND BUSINESS RULES MANAGEMENT

Business rules are defined by the Business Rules Group as "constrains [....] that guide or limit the business" [7]. Business rules are specific instantiations of rules and capture process and enterprise specific knowledge. Business rules are often categorized in different types such as, e.g., constraints, derivations or process rules [7-10]. Constraints are statements concerning the enterprise or its philosophy that need to be always true [7, 11]. Derivation rules are statements that are derived from other information or given facts, e.g., calculations. Process rules describe the process logic, i.e., sequence of process steps execution, and are often

 ISBN: 978-1-61208-223-3

known as ECA (event, condition, action) rules. One of the main concerns in business rules management is their extraction and identification from the business process context. Here, the process by [12] is described and applied for business rules extraction from a business process model.

First, the area of analysis, i.e., the scope of business rules extraction, needs to be defined. Here, the area is well limited being the self-contained business process model. Further, identifying the goal of analysis helps the evaluation of the importance of involved potential business objects that can be business rules' sources or sinks. For the given experiment, the goal is to capture all business rules involved for efficient and accurate process execution using the existing business process model. The goal of this process can be identified as providing an optimal care for the patient from medical, financial and temporal points of view.

Further, a mandatory business vocabulary of the terms used in the analyzed context needs to be established. Process- guiding rules can often be identified by the use of a gateway in a modeled process flow, which can be seen as the first step for business rules identification [13]. Questioning the implicit (or explicit) pre- and post conditions of a process steps realization can also provide a indication on business rules that are needed to achieve successful automated process execution. For identification of further potential business rules sources pre- and post-conditions for the process goal achievement can be helpful. Next step of the process suggests the identification of the process stakeholders. Possible restrictions coming from the stakeholders need to be specified and their impact on the process or analysis goal evaluated. An important structuring criterion for found business rules candidates is their affiliation to the goal of the analysis. Stakeholders' restrictions can be summarized as expectation of: maximum transparency (including clear and comprehensible decision guidelines), minimal possible processing time (maximum possible process automation), maximum benefit (including clear accordance of requirements and possibilities), maximal possible accuracy (meaning clear decision guidelines and clear requirements assessment).

Business rules are especially useful in business domains with high decision and policy intensiveness because they enable expressing, managing and updating pieces of business knowledge [14]. As the definition of the process type requires significant analysis effort, Levina and Hillmann [15] show a quantitative approach for business process type identification. In the context of business rules management, information and collaboration intensive processes are in the focus of interest as they would benefit from business rules-oriented management approach.

The business rules management approach [10, 16] is often seen as a part of business process management [17] and is also intended as an enabler of process improvement. Among the main reasons for integration of business rules management following business domains are cited by practitioners and researchers: decision automation to reduce process complexity and transaction costs of and decision errors within a process task; process flexibility due to the ability to update or extend the business logic using a business rules management system; spreading and harmonizing business policies and agreements throughout the enterprise [18-20]. Nevertheless, the claimed benefits of the business rules approach are rarely empirically investigated in research. The major part of business rules management research is focused on structural and operational construction of business rules for accurate response to changes in business environment [21] or is often related to complex event processing.

In this paper, process cycle costs and time are analyzed aiming at the investigation of the effect of business rules automation on process efficiency by comparing performance indicator values of the as-is and to-be process. Therefore, a real-life business process in the as-is state as well as with automated business rules is simulated using a business process modeling and simulation software. The assumption here is that business rules and workflow management systems create an integrated environment for process execution.

III. RELATED WORK

Vendors of business process and business rules management solutions often provide case studies on the positive effect of business rules automation based on their customer's experience (see e.g., [5]). Nevertheless, this data cannot be rigorously evaluated, as these case studies are described on an abstract level. Furthermore, data collection methods and analysis are neither discussed, nor presented in the corresponding publications. Thus, these case studies cannot be considered in full in this state-of-the-art review of current research on business rules management assessment.

In the research area of business process management, business process simulation has been widely used for business process re-engineering [4, 22, 23] as well as organizational design [3] and quality assessment [24] among other domains. Simulation is furthermore a component of a business rules engine, thus, business rules can be simulated to provide a better robustness and validate the process and rule design.

Research on business rules often focuses on business rule description [17], data management aspects and technical implementation [21, 25, 26]. Only little research has been done in the area of business rules capturing and extraction methods [12, 19, 27, 28] as well as evaluation of the business process management approach on business process performance. Levina et al. [1] explore the impact of business rules automation in the e-business domain using complex event processing, i.e., event-action/process business rules. The indicator used to show the advantage of business rules in [12] is process cycle time. The case study also focuses on a short business process that involves only few decisions.

In this paper, a case study that requires extended process knowledge as well as frequent decision taking is analyzed. The effects of business rules automation are measured using process costs and time indicators. Next section describes the experiment design.

 ISBN: 978-1-61208-223-3

IV. EXPERIMENT DESIGN

To assess the business rules automation effect, a simulation of a business process from a German health fund has been performed. The process was elcited using interviews and modeled using Business Process Modeling Notation (BPMN) as well as enriched with detailed information on its organizational, temporal and financial structure. This proceeding provided a way to achieve an understanding about the current and future potential design of organizational processes without the risk of disruption to the real system itself.

Derived information as well as the business processes have been modeled using Adonis® 2.01 community edition software. This open source tool allows BPMN modeling as well as process simulation. To derive the effect of business rules automation on the business process, the process has been modeled and simulated using two different scenarios. In the first scenario, the as-is process described in interviews has been represented. In the second scenario, identified business rules have been implemented in the model. Hereby, process rules as well as constrain rules have been modeled as automated tasks, while rule-centered information gathering and management have been implemented in the first scenario as manual tasks. Duration of the simulation was a year in working days with five working days per week and 8 hours per week per day for both scenarios. Duration of automated tasks has been set corresponding to the values elevated in interviews. Activity costs were assigned in accordance with process actors' levels of expertise. Activities requiring deeper medical knowledge were assigned higher costs comparing to less knowledge intensive activities.

A. Methodology

A case-based research methodology was chosen with the aim to provide an example of practice and test the proposition that the supporting tools of process mapping and business process simulation can illustrate the effect of a rule-based approach to change in the context of business process management.

Although, a single-site study has obvious limitations with respect to the generalizability of the findings, the case is not aimed at being representative, but rather exemplary. Thus, the simulation results that were retrieved using the simulation are not exhaustively representative of all similar situations (same reasoning has been successfully applied in [29]). The study is used here to explore the potential effects of business rules externalization and automation on business process performance. Therefore, it is an explanatory example and an exploration study which simulation results indicate the effect of business rules automation. The process used here shows attributes of business rules-intensive processes as well as the potential of automation of its sub-processes (see [15] for business process type definition and identification).

Thus, the approach for business process simulation suggested by Hlupic and Robinson [22] is adopted in the presented research. To derive research results following steps are performed:

- Define modeling objectives;
- Decide on model boundaries;
- Collect and analyze data;
- Develop business process simulation model;
- Test model;
- Model experimentation;
- Analyze output;
- Provide business process change recommendations.

Hlupic and Robinson [22] suggest this proceeding for evaluation and decision support in the context of re-engineering, thus the last phase is omitted here, because the goal of the research is exploratory rather than recommendatory. The case study roots in a business process analysis project where the process under consideration had to be defined, modeled and explored concerning its potentials for automation. The resulting as-is model and process information was used here as input for simulation design.

Thus, the modeling objective is to document and analyze the as-is as well as to-be processes. The model boundaries have been set according to the project scope, i.e., the patient management process by health and medical managers. The as-is process model, including execution time and costs of the tasks as well as the designed to-be process model have been discussed and evaluated with process workers and process manager. As mentioned above, the process flows have been modeled and task characteristics such as their execution costs and times have been included to enable the simulation of the quantitative characteristics and thus performance measurement. After the short process and simulation set-up descriptions in the following sub-sections, the accordant simulation results are presented and discussed.

B. Process Description

The process under analysis aims at the provision of a suitable control of patient treatment. Process goal is to provide efficient and suitable treatment corresponding to the patient's diagnostics for the patient and the health fund. The challenge for the health manager at the health fund is to understand the diagnosis of the patient and to evaluate which treatment can be suitable for an efficient recovery. Thus, a certain amount of medical knowledge is needed to guide the treatment process.

 ISBN: 978-1-61208-223-3

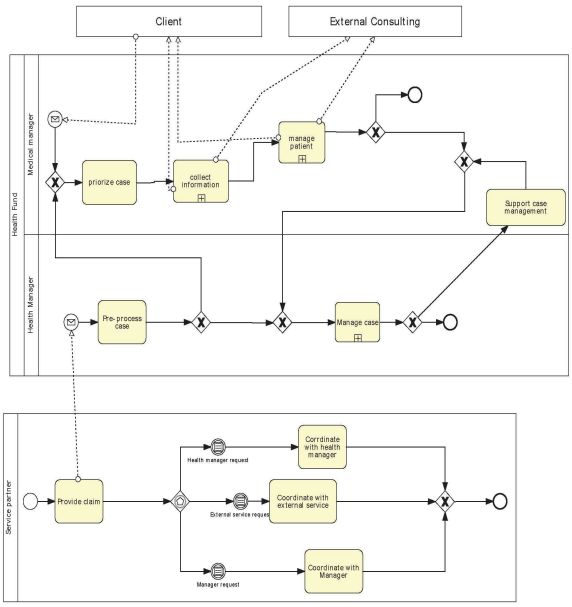

Figure 1. Health fund process

The process presented in Figure 1 starts with a message or request about the medical case filed by the patient or treating facility in cases when the patient had to be delivered to the hospital or is already under medical treatment. This case is analyzed by either by the health or medical manager with the regard to sufficiency of the included data. If all needed information is given, either within the case or in the patient history available at the fund, the case is evaluated concerning its complexity. If health manager classifies the case as clear, he or she supervises further treatment. If he or she doubts whether her or his knowledge is sufficient for further handling the case, he or she can pass the case to a worker who has an indicated higher medical knowledge, i.e., medical manager. In this case, medical manager is responsible to govern the treatment. Thus, medical manager often acts in a consulting position for the health manager or reworks cases that could not be managed by the health manager.

Governance of the treatment is composed of several steps. Diagnostics of the patient needs to be comprehensive and his or her nursing assessment needs to be identified. According to this data a general treatment proceeding can be planed. This proceeding is discussed with the patient. According to the diagnostics a specialist or a treatment facility, such as a hospital or a rehabilitation institution, needs to be chosen. The choice depends on the current list of partner institutions, their availability or agreements between the health fund and medical specialists. Furthermore, according to the treatment plan, costs of the treatment need to be reviewed and monitored along the treatment process. External consulting provides support upon request in cases where the diagnosis or treatment activities are not clear. Thus, we can identify following actors involved into this process: patient, treatment facility (that can also be a medicine or a hospital), external consulting, the operative health and medical manager from the health fund. The goal of this process can be identified as: provide an effective patient treatment. The term efficiency implies best possible recovery of the patient and efficient resource involvement (such as costs and time) on the side of the health fund.

While in the described as-is process the information collection and decision making have been performed manually, in the course of to-be process design, business rules as well as process automation potentials were derived and implemented into the process model. The goal of the to-be process was to reduce the process time and costs for the health fund while providing the right treatment, i.e., efficient process for the patient and health fund. This goal is consistent with the as-is process goal. Therefore, the work load of the medical manager has been reduced using a more effective decision making and information collection. Identified business rules were supposed to be externalized in a business rules management system to reduce process time. The simulation of the as-is and to-be processes is now applied to assess the performance difference between the two scenarios using process time and cost metrics.

C. Simulation Set- up

Conducted interviews with process workers and managers were led to capture the process as well as to provide information on process times and indications for derivation and constrain business rules. Business rules that are relevant for process execution have been identified as mostly being of type constraints and process rules indicted by control flow gateways. Additional business rules as well as process rules have been derived using the business process model (see BPMN rule events in Figure 1) and business rules extraction process described above. Additionally, decision points within the process were identified and the accordant information has been gathered. Decision points indicate process stages or tasks that require additional data for decision making [30] and are thus potential sources of business rules enactment.

Furthermore, the as-is process has been modeled including the as-is process implementation, i.e., manual information gathering has been represented as manual tasks. This as-is model has been simulated using Adonis® 2.01 community edition software and the defined performance indicators such as time and estimated costs in money units (MU) of the process have been observed. The process has been simulated for a time-span of a year to gather average costs and frequencies of the single activities, as well as to take into account that a patient recovery needs to be accompanied for a longer period of time, that is, until he or she likely does not need any medical attention for the original diagnosis anymore. Thus, monitored frequencies and costs of activities represent the real process without being exhaustive and based on simulation rather than on the actual execution patterns.

In a next step, the as-is process model has been modified to a to-be process to include identified and automated business rules. Thus, constrain rules have been treated as information collection points [30], i.e., information gathering, as well as constrain estimation has been

 ISBN: 978-1-61208-223-3

automated. In the actual realization of this automation e.g., a document management or business rules management system can be used. Process rules have been modeled as automated, by e.g., a workflow management system. Subsequentially, this to-be process has also been simulated with the focus on the described performance indicators. While the as-is process data on time and cost management have been gathered in interviews, data in the to-be process have been estimated and evaluated using experience and expert interviews. As the result, two of the manual process activities of the as-is process have been fully automated in the to-be process.

V. SIMULATION RESULTS

Simulation of the as-is process resulted in an average time for the case support (in working days) of 8 days and approx. 7 hours with estimated costs of 69.62 MU (see Table 1). As the most frequent activities in the process "manage case" activity performed by the health manager as well as "prioritize case", "gather information" and "manage patient" by the medical manager have been identified. "manage patient" was identified as the activity with the highest costs (25.2 MU) as well as with a rather high average frequency of execution in a process cycle (0.84).

Simulation of the to-be process resulted in a reduced process time by 37.5% as well as reduced estimated costs by 17.3%. Although, in the to-be process the number of activities for health manager increased, his or her workload is now more focused on the efficient case processing and his or her area of expertise. "manage case" activity is now performed with a lower frequency while health manager also performs "manage patient" activity. This fact is also beneficial for process efficiency as the time of the medical manager is more expensive comparing to the time of the health manager due to their different levels in medical knowledge. In the to-be process medical manager is less involved in the support of health (frequency of the "support case management" activity is decreased), while being slightly more involved in patient management.

TABLE I. SIMULATION RESULTS

Indicator	As-is values	To-be values
Process time	8d 6h 47min	5d 7h 42min
Process costs	69.62 MU	59.37 MU
Performance Quotient (MU/min)	0.00584	0.00775
Manage patient (frequency; costs)	0.89; 25.20	1.19; 35.55
Gather information (frequency; costs)	0.84; 25.20	0.92; 18.39
Support case management	0.43; 6.5	0.21; 3.15
Priories case (frequency; costs)	0.84; 8.4	0.8; 1.6
Pre-manage case (frequency; costs)	0.4; 2	0.4; 0.8

In the to-be process activities "gather information" and "manage patient" are the most frequent and expensive activities performed by medical manager. They are "routine" activities for the medical manager with frequencies of 0.92 and 1.19 respectively, as well as respectively requiring the costs of 18.39MU and 35.55 MU. An additional, though a rather obvious observation, is that the rise of frequency of these activities is accompanied by a nearly proportional rise in costs (frequency rise of 42% was accompanied by rise of the costs by 41.1%). Another effect of business rules automation can be observed on the two process tasks that have been automated: "priorise case" and "pre-manage case". Their occurrence frequency remained nearly the same but their costs were reduced to a fraction of the original costs. Hence, the automation of the to-be process resulted, among other, in a higher number of activities for health manager as well as the supporting information system.

Finally, to be able to compare the performance of the two processes, their performance quotient has been calculated. The performance quotient of the process has been defined here as the relation of the process cycle costs (in MU) and process cycle time (in minutes). As the result of this analysis, the to-be process performance increased by 24.65% comparing to the as-is process performance. This rise can be attributed to the business rules automation regarding the experiment design and simulation results.

VI. CONCLUSION AND OUTLOOK

In this paper, simulation-based experiment and its design for the assessment of the effects of business rules automation on business process performance has been illustrated using a process modeling and simulation software. The focus of this business rules simulation was put on constrain as well as process rules as they provide the highest process enhancement potential when realized using IT-supported execution. Experiment results show that the process performance of a to-be process involving automation of the business rules that were identified and externalized from the as-is process using a systematic approach was increased. This performance rise is attributed here to the business rules externalization and automation.

Applied research approach can be used as a basis for estimation of the business rules automation benefits. One major limitation of the presented results though, is the fact that the experiment design takes neither the investment, nor the implementation costs for business process and business rules automation infrastructure into account. Additionally a general limitation of business process simulation is that each modeled scenario represents only one possible outcome and over long periods of time these outcomes could be greatly different to actual performance. It is therefore essential to undertake a series of experiments and judge the sensitivity of model results to changes in input factors. This will provide some indication of how useful the simulation results are likely to be. Nevertheless, this paper assessed some of the claimed benefits of the business rules management approach. Here, its effects on process improvement or efficiency have been addressed.

This paper illustrated that the performance of a (rule and information intensive) business process can be enhanced considering the indicators time and cost using business rules automation. Considering business rules in this process also resulted in a process workload and responsibilities for the process actors that are now more fitted to the job description.

 ISBN: 978-1-61208-223-3

This fact needs to be examined in future research, as it may provide an indication towards a measurable effect of psycho-social dimensions such as higher job satisfaction on process performance. Further research directions are to explore the effects of business rules management approach on process and data maintenance costs, compliance, update related efforts as well as decision accuracy.

VII. REFERENCES

[1] Levina, O., Kubicki, A., Holschke, O. and Rake-Revelant, J., Exploring the Impact of Business Rules Consideration on Processes in E-Business, in 2nd IEEE International Conference on Information Management and Engineering. 2010, IEEE: Chendgu, China.

[2] Simon, H.A., Applying Information Technology to Organization Design. Public Administration Review, 1973. **33**(3): pp. 268-278.

[3] Giaglis, G., Paul, R. and Hlupic, V., Integrating simulation in organisational design studies. International Journal of Information Management, 1999. **19**(3): pp. 219-236.

[4] MacArthur, P.J., Crosslin, R.L. and Warren, J.R., A strategy for evaluating alternative information system designs for business process reengineering. International Journal of Information Management, 1994. **14**(4): pp. 237-251.

[5] Robbe, N. The Business Rules Advantage for Process Improvement. in BrainStorm New York. 2010.

[6] Hevner, A.R., March, S.T., Park, J. and Ram, S. , Design Science in Information Systems Research. MIS Quarterly, 2004. **28**(1): pp. 75-105.

[7] BusinessRuleGroup. The Business Rules Group. Defining Business Rules – What Are They Really? [cited June, 2012]; Available from: http://www.businessrulesgroup.org/first_paper/br01c0.htm.

[8] Ross, R., Principles of the Business Rule Approach. Management Information Systems. 2003: Addison- Wesley.

[9] Taveter, K. and Wagner, G. Agent-Oriented Enterprise Modeling Based on Business Rules? in 20th Int. Conf. on Conceptual Modeling. 2001. Yokohama, Japan: Springer.

[10] von Halle, B., Business Rules Applied. 2002: Wiley & Sons.

[11] Schacher, M., Grässle, Patrick, Agile Enterprises through the Business Rules Approach (In German). Xpert. press Series. 2006: Springer.

[12] Levina, O., Holschke, O. and Rake-Revelant, J. Extracting Business Logic from Business Process Models. in 2nd IEEE International Conference on Information Management and Engineering. 2010. Chengdu, China: IEEE.

[13] von Halle, B., Goldberg, L. and Zachman, J., Business Rule Revolution. Running Business the Right Way. 2006: Happy About.

[14] Charfi, A., Mezini, M. Hybrid web service composition: business processes meet business rules. in 2nd international conference on Service oriented computing. 2004. New York, USA: ACM.

[15] Levina, O. and Hillmann, R. Network-based Business Process Analysis in 45th Hawaii International Conference on System Sciences. 2012.

[16] Ross, J., W., Creating a Strategic IT Architecture Competency: Learning in Stages. MIT Sloan Working Paper 2003..

[17] Muehlen, M.Z., Indulska, M. and Kamp, G. . Business process and business rule modeling languages for compliance management: a representational analysis. in 26th international conference on Conceptual modeling. 2007. Auckland, New Zealand

[18] Eijndhoven, T.V., Iacob, M. and Ponisio, M. L. Achieving Business Process Flexibility with Business Rules. in IEEE International Enterprise Distributed Object Computing Conference. 2008.

[19] Gottesdiener, E., Harvesting Business Rules in Workshops. DataToKnowledge Newletter (now Business Rules Journal), 1999 27(2).

[20] Graml, T., Bracht, R. and Spies, M. Patterns of Business Rules to Enable Agile Business Processes. in 11th IEEE International Enterprise Distributed Object Computing Conference. 2007.

[21] Resch, O., Six Views on the Business Rule Management System. e-Journal of Practical Business Research, 2010. 11.

[22] Hlupic, V. and Robinson, S. Business process modelling and analysis using discrete-event simulation. in Proceedings of the 30th conference on Winter simulation. 1998. Los Alamitos, CA, USA: IEEE Computer Society Press.

[23] Swami, A. Building the business using process simulation. in Simulation Conference. 1995: IEEE.

[24] Wong, K., Parkin, R. and Coy, J. , Integration of the Cimosa and high-level coloured Petri net modelling techniques with application in the postal process using hierarchical dispatching rules. Journal of Engineering Manufacture,, 2007. 221(5): pp. 775-786.

[25] Rosenberg, F. and Dustdar, S. , Towards a Distributed Service-Oriented Business Rules System. Web Services, European Conference on, 2005: pp. 14-24.

[26] Rosenberg, F. and Dustdar, S. Design and Implementation of a Service-Oriented Business Rules Broker. in: Proceedings of the Seventh IEEE International Conference on E-Commerce Technology Workshops. 2005. Washington, DC, USA: IEEE Computer Society.

[27] Bajec, M. and Krisper, M., A methodology and tool support for managing business rules in organizations. Journal of Information Systems, 2005. **30**(6).

[28] Bubenko, J.A. and Wangler, B. Objectives Driven Capture of Business Rules and of Information Systems Requirements. in Systems, Man and Cybernetics, 1993. Systems Engineering in the Service of Humans, Conference Proceedings.

[29] Stuart, I., McCutcheon, D., Handfield, R., McLachlin, R., and Samson, D., Effective case research in operations management: a process perspective. Journal of Operations Management, 2002. **20**: pp. 419–433.

[30] Levina, O., Design of Decision Service Using Cause-and-Effect Business Process Analysis. Computer Science- Scientific Journal of Riga Technical University, 2011. **46**: pp. 19-27.

 ISBN: 978-1-61208-223-3