Design of Decision Service Using Cause-and-Effect Business Process Analysis

Olga Levina, *Berlin Institute of Technology, Department of Systems Analysis and IT*

***Abstract* – Business processes are executed according to a specific business logic that can be formulated as business rules. Often decisions are taken during the course of the process to fulfill conditions or exceptions leading to process variations. These decisions are meant to support business process operations and are composed of a set of business rules, additionally being based on a solid process relevant knowledge and know-how. These processes are here referred to as decision knowledge intensive processes. In this paper the question of how business rules and consequently operational decisions can be derived from the business process model is addressed. The therefore necessary business process analysis and decision identification are performed using the cause-and-effect approach. Service-oriented implementation of the found decisions is suggested and outlined.**

***Keywords* – decision management, business rules, business process, service design**

I. Introduction

Finding the right decision is important in different stages of the business process and on different levels within the enterprise. Two major types of decisions that are needed to complete a business process can be differentiated: decisions influencing the process outcome and decisions that are needed to define or support the vision or goal of the business. This rough classification will be refined further in section 2. Furthermore, business processes can include a different number of decisions throughout their execution. Especially in decision intensive processes [4], the question arises, how decisions can be automated or effectively supported by business application systems. Here we discuss the discovery and implementation of operational decisions into machine-executable software components, i.e. services.

The initial research question addressed in this paper is twofold. First, the question of how decision knowledge can be derived from a business process model is addressed, as process models already exist in many enterprises and thus are containers of relevant process and operative knowledge. An additional argument for the chosen research process is that process models still often provide a basis for process and enterprise analysis. The second question is how this rather unstructured and often tacit knowledge that is included in the process models can be analyzed considering the decision logic and how this logic can be implemented for an automated process support.

This paper approaches these questions in two different ways. First a case study was conducted to resume a decision intensive process. The process was captured in several expert interviews and modeled using BPMN v1.2 to achieve a structured overview and a better understanding of the process. The process under observation is a business process carried out by a health fund and the interviewed experts are the operative workers who perform this process as their core professional activity. The process was identified as a potentially decision intensive based on its description by the experts as being "complex", "knowledge-intensive", "dependent on personal [i.e. workers] decisions", "hard to describe" and "variable". All of the employees involved in these activities were interviewed; the process model and description were reviewed by the interviewees for quality assurance.

The conducted interviews were half-structured and the goal was to capture the processes including its activities, exceptions and actors. Decision context was mentioned neither before, nor during, nor after the interviews to avoid potential bias in the interview content [10]. As soon as the correctness of the process model and description were assured, the analysis was conducted. The goal of the analysis was to identify business rules that guide the process logic and decisions that have to be made to achieve the process goal. For this process analysis the cause-and-effect approach was chosen. This choice was made according to the understanding of business rules as presented in section two.

Thus, here the design science research approach with a heuristic technological rule as a result (using the terms of van Aken [25]) was used to answer the research questions. As the research is based on a case study, thus an inductive research method was used for decision service derivation. Process analysis, preceding service design, was conducted using a cause-and-effect approach, thus a deductive method was used. Combining the two approaches allowed the achievement of two goals: a general process analysis and application dependent service derivation and design. The study results in actionable artifact such as a structured proceeding to design of decision services and therefore implementation of decision management in the enterprise. This approach supports not only business analysis that aims at reengineering and restructuring of the business processes but also contributes to service design, i.e. automated support of the business processes.

The paper is organized as follows: Section two discusses decisions and decision intensive processes. It also introduces the term decision knowledge intensive process that is used in this paper. Section three describes the business process under analysis and presents analysis results concentrating on the analysis process, identified business rules. Decision services are defined and business rules are composed into decision rule sets and thus into services in section four. Section five reviews related work on enterprise decision management and decision services. Conclusion and outlook finish the paper.

II. Defining Decisions and Business Rules in Enterprise

This section provides a short overview of the terms used throughout the paper. First, decisions in business processes are defined and their relations to business rules are outlined. Business rules are defined and the cause-and-effect analysis is presented and discussed.

A. Decisions in Business Processes

Business process-oriented approach for enterprise analysis and automation gained momentum since Hammer and Champy [8] partly due to the increasing shift from production enterprises to knowledge-based business models. While today business process automation supports recurring, well structured processes through workflow systems, knowledge-based or event-intensive processes are regarded as unstructured and hard to automate [24]. *Decision intensive* processes can be referred to as knowledge-based processes. One possible definition of a decision intensive process is: "[a] Repeated and repeatable business processes whose conduct and execution are heavily dependent upon knowledge workers in a variety of roles performing various decision making tasks that interconnect to drive critical organizational outcomes" [4]. This paper elaborates on the definition of the decision intensive process, under the aspect of rule and knowledge structure involved in the decision.

A *decision* is defined here as a choice between several process variants rather than a choice between two alternatives. First, the assertion is made that a decision is a set of rules, i.e. logic that guides the decision. In an enterprise context a business related decision is a set of business rules in terms of [6]. It is not always possible to identify the rules that guide a decision. That is why we distinguish here between operational and strategic decisions [22]. Strategic decisions aim at high level and thus more general business managerial aspects, such as long- or middle-term investment plans, target markets or price building. Rules guiding these decisions are hard to identify and externalize, as they depend not only on business logic or policy but also on several other aspects such as general economic state, strategic management behavior and style, etc. Figure 1 shows this decision classification based on the decision pyramid by Anthony [1].

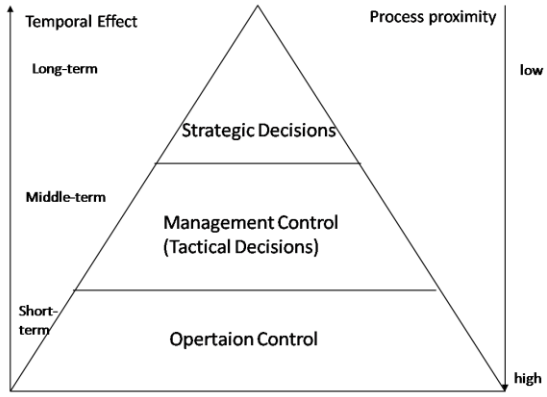

Fig. 1. Decision pyramid based on [1]

Strategic decisions concern organizational goals and objectives. Here the information needed to take a decision is most often incomplete and the decision process extends over a considerable period of time [2]. Tactical decisions are mostly associated with decisions on identification and use of resources, while operational decisions assure the effectiveness of the operations performed in the enterprise [2].

Here we concentrate on the operational decisions as they need to be performed often during the course of the process and are taken in a relatively short time. Thus, they can be asserted to the category of structured decisions as they are: repetitive, and are taken within a clearly defined process [2], according to specified (business) rules. This characteristic also supports automation of the decision description and performing.

The decision making pyramid by Anthony [1] is extended in Figure1with the temporal and process-oriented parameters. The temporal dimension covers not only the time needed to take the decision but also the time period of the decision effect. The dimension of the *process proximity* indicates the level of process the decision effects apply to. It ranges from process results with low process proximity down to process activity, i.e. high process proximity. Strategic decisions and management decisions refer to organizational goals and visions as well as to the use and identification of resources respectively. Operation control implies decisions on the level of process tasks, thus providing the highest process proximity. Operative workers, i.e. workers who complete more or less routine processes, have to make decisions on a finer, process-related scale. These decisions perform the guiding process logic and often need to access multiple different information sources, e.g. other processes, process actors or process collaborators. Such processes are here called decision knowledge intensive processes, as not only the operative knowledge but also knowledge on information sources and harvesting is needed to make a decision.

Thus, *decision knowledge intensive processes* are characterized by multiple decisions that need to be made along the business process and increased information needs to support the decision. The term is introduced here as the amount of the required information can vary depending on the process and its context. The definition is based on the abovementioned definition of decision intensive processes, but it extends the definition by the information aspect. The concept implies that the information and knowledge needed to take a decision concern not only business rules, policies and the process know-how by a worker, but is also based on several criteria the fulfillment of which depends on hidden information, i.e. that is stored in files or needs to be obtained first. To make a valid decision, knowledge about its guiding rules, their contents and outcomes is needed. This knowledge and information are here called *decision information cluster*. It includes business rules and policies that are needed to make a decision.

B. Defining the Business Rules

Business rules are defined by the Business Rules Group as "constrains [....] that guide or limit the business" [6]. Business rules are specific instantiations of rules. It is not easy to find a general definition of a rule that is context independent. Often rules are statements that describe usual behavior, though this behavior is not mandatory. Rules are also used to prescribe certain behavioral patterns or to provide a logical connection between different entities or their characteristics to provide a certain effect. In business context rules are understood as declarative statements on business process behavior [30]. To sum up these different views on rules, the following definition will be applied throughout the paper: a *rule* is a declarative statement that relates a certain data and facts combination K with an effect E. This definition provides a view on a rule as a statement on the conditions (or causes) that need to be fulfilled to provide a required effect. Using the terminology of the propositional calculus and algebra, a rule R can be summarized as a function where the set of data and facts K is associated with a set of effects E. Thus, $R: K \rightarrow E$, such as the combination of elements in set K is associated with an element or a set of elements in set E; whereas an effect can be an action, a new data or fact.

Business rules are often categorized in different types such as e.g. constrains, derivations or process rules [16, 30, 28, 6]. The Business Rules Group uses the more abstract definition that has already been cited above. Here business rules are seen as specifications of rules as defined above. Therefore, the reasoning is done without differentiation among business rules types. Furthermore, the view on business rules as statements that provide a logical connection between occurring data and facts, and the resulting effect supports the choice of cause-and-effect analysis to approach the given questions.

C. Cause-and Effect Analysis of Business Processes

On all the levels of the decision pyramid in Fig. 1 decision-making depends on the information or the amount of the information needed. Here not only the amount itself is a critical aspect, but also the sources and the relevance of the sources are important factors of the decision. Thus, the process elements that indicate the need for further information are defined as *decision information points*, in the sense that they are expected to contain information or knowledge needed to make a decision that leads to the successful realization of the aspect that leads to the process goal. Each of them is involved in a (set of) decision(s) that requires the accordant information; thus being an element in a decision information cluster. Identification of these sources is approached here using the cause-and-effect analysis. This approach is chosen here to identify the roots, i.e. the most relevant information sources of a decision being a set of conditions that lead to rule triggering. This proceeding addresses the fact that for decision making too much information can be as bad as too little information.

Consequently the multiple-causes-one-effect analysis pattern is used in this paper for derivation of decision services. The causality here is business-driven, i.e. business goal-oriented and qualitative rather than related to causality relations common in econometrics. An *effect* describes a process result and a *cause* describes the conditions or other sub-effects that need to be fulfilled to achieve the effect on a macro- and the rule result on a micro-level. This terminology is chosen here, as it describes the nature of decision-making. Decision-making is often built on assumptions, embedded in certain circumstances and produces a result that affects the system as a whole or its elements. On the other hand the cause-and-effect analysis is an enabler of the presentation of the dynamic elements in business processes. The use of cause-and-effect diagrams or trees allows differentiating between the static (effects) and dynamic (causes) aspects of a business process. Business processes change often in the order or manner of their tasks execution as in a volatile environment the cause for a specific order or the order itself may change, but the process goals, i.e. the effects, remain mostly the same. Reflecting on the effects and its causes captures the status quo of the process while also providing a structure that is rather flexible while still containing stable points of reference.

Decision-making itself though, is often an unstructured, heuristic and iterative process with many interdependent elements [2]. It is also to say that a decision is a consequential act, i.e. it can trigger a (re-)action or is a cause of some effect. Based on this thought, the possibility arises to apply the cause-and-effect based analysis to decision knowledge intensive business processes. Cause-and-effect analysis organizes a large amount of information by showing links between events and their potential or actual causes also enabling a broader thinking and overview of a problem. Here it is used to understand the guiding process logic to derive necessary decisions. The chain approach, instead of the fishbone diagram [9] that is often used as a quality management technique, is chosen to visualize the logical dependencies within the process. This approach is illustrated in the following section.

D. Business Process Models and Automation

Process models are abstract representations of business processes. They are usually created by business analysts or managers with the goal to improve the quality and effectiveness of current processes. Thus, the goal is to represent the course of actions rather than to capture its guiding logic. Though, this aspect is included tacitly in the model. The question arises, how to identify the business logic and the decision clusters from the business process and how to implement them into an automated process execution. Here the approach of combining business rules into decision services based on cause-effect-relations in the process is chosen. The realization of decision services suggested here is based on the Web Service technology [29] and implemented into a service-oriented architecture (SOA). A *service* in this context is: "…a self-describing, open [software] component[s] that support rapid, low-cost composition of distributed applications" [15] with the following characteristics: "[…] autonomous as well as interoperable and provide re-usable functions via a technically standardized interface" [19].

III. Process Model and Element Relations

Here a process taken from a case study at a health care fund is shortly described. The process aims at the provision of a suitable control of the patient's treatment. The purpose here is to provide suitable treatment according to the patient's diagnostics and minimize his or her errands to find a specialist. The challenge for the operational worker 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.

The process starts with a message or request about the case filed by the patient or the treating facility in cases when the patient had to be delivered to the hospital or is already under medical treatment. This case is first analyzed by an operative worker concerning the 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 the operating worker classifies the case as clear, he or she supervises the further treatment guidance. 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. In this case, this medical worker is responsible for governing the treatment.

The governance of the treatment is composed of several steps. The 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 procedure can be planed. This procedure 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.

Thus, we can identify the following actors involved in this process: patient, treatment facility (that can also be a medicine or a hospital), the operative and the medical worker from the health fund. The goal of this process can be identified as to 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.

The approach chosen here to analyze the process is based on cause-and-effect relations. The process goal is seen here as the effect that was originated by several causal aspects. This approach allows the exploration of causes and events leading to the expected effect. So the guiding analysis question is: what aspects lead to the achievement of the process goal? Deriving from the process description these are the main aspects that were identified and depicted in Figure 2: qualification knowledge of the person in charge of the treatment guidance; completeness and correctness of the information needed to understand and process the case; resources that can be assigned and are available to process the case.

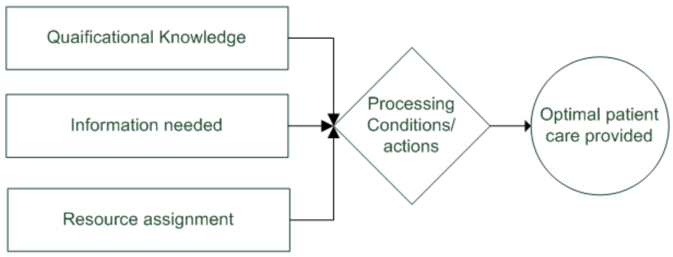

Fig. 2. Causes and the effect of the patient treatment decision process

Figure 2 also implies that the processing of these aspects is needed to achieve the goal set for the process. This processing is likely to follow the business logic and thus includes business rules. Thus, the achievement of the optimal patient care depends and is caused by the availability of the three aspects such as information, qualification and resources.

In the following chapters some of these aspects and their implied decisions are described in more detail. Furthermore, as already evident from the process description, this process contains multiple decisions that form the central characteristic of the process. Starting points of the decisions are the three identified causes of the process goal, i.e. decision information points. These are also the aspects that need additional information for an equivalent decision making. Thus, this process can be categorized as being a decision knowledge intensive process. Finally, the decision on whether the optimal care is provided depends on the quality of the information that is collected from each of the causes, i.e. the decision information points. What information is needed or how it is to be evaluated is defined in the processing element of the Figure 2. Obviously it contains the business logic that is captured either in business rules or the knowledge of the operative workers.

IV. Deriving Decision Services

In this section the process of decision identification and their implementation is presented. The decision information points were identified in section three as aspects containing information that causes a positive process goal achievement. The process of the decision identification (see also Figure 5) starts with the identification of business rules of the business process. This step is followed by their clustering into decisions. Several decisions can subsequently be summarized in a decision service. This decision process resembles a workflow that is composed of decision services that need to be created to support the business process. The rules within the services define in more detail what conditions need to be respected and what operational consequences result from the indicated actions.

These business rule clusters are also respectively elements of the decision information points, i.e. they are causes that lead to the optimal patient treatment effect and are thus part of the crucial information needed to achieve the process goal. To extract this information an approach to business rules identification in shown in the following subsection.

A. Business Rules Identification

As there are three main information decision points in the analyzed process we will concentrate on only one of them being the harvesting of the needed *information* as one of the complex aspects. Thus, now we consider the aspect of information that is needed to make a decision on the treatment plan as the effect and explore the factors that lead to the achievement of this effect. Information is considered as complete when the information on the patient, his or her medical history as well as the information on the available treatment institutions such as hospitals or rehabilitation facilities is given.

As the causes of the needed information are now identified, relevant data that is potentially contained in each of the decision information points can be collected. The data can be found in documents and other possibly less structured knowledge sources like personal process experience of the worker or the business policies are the foundation of the cause under analysis. The knowledge included in these documents is important as it is needed to make a decision and is therefore referred to as decision knowledge. The cause-effect relationships as well as the direct decision knowledge sources for the information aspect are presented in Figure 3. Identifying these sources, i.e. information harvesting, is one of the main challenges of the founded decision making.

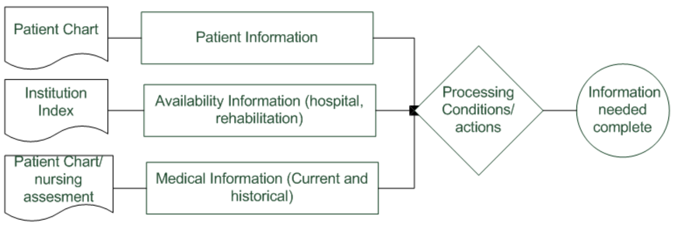

Fig. 3. Causes and data sources of the “information needed complete”-effect

Once the decision information points and the accordant knowledge sources are identified, the logic of their processing needs to be defined and formalized. This logic is then externalized into business rules first in a natural language and later if possible in a machine processing language. Here the possibility arises to define business rules that are related to each of the aspects and then cluster them as decision sets that lead to the main evaluation of whether the needed information is complete.

TABLE I

CAUSES AND BUSINESS RULES OF THE INFORMATION “NEEDED COMPLETE” EFFECT

Cause	Knowledge/Information	Business Rules
1.**Patient Information**	- Personal, Insurance Data - Medication - Medical Support - Additional Aspects	1.1 Store patient data in an electronic file 1.2 Update patient file after every medical treatment change; …..
2.**Medical History**	- Diagnostics - Former Medical Conditions - Current and Historical Chart	2.1 Medical history is stored as a paper document and as an electronic copy; 2.2 Historical patient chart is stored as an electronic copy; 2.3 Important medical information includes: diagnostics, current patient chart; 2.4 Mandatory medical information: historical chart, former medical history; 2.5 IF information is clear; THEN get in contact with treatment institution; ELSE contact the medical support to complement the medical information …..
3.**Availability Information**	- List of Partner Treatment Institutions - Capacity of the Institution	3.1 Only institutions the fund has a contract with, are partners 3.2 Only partners in the direct living area of the patient are members of the short list 3.3 Get the short list of related institutions; Select potential institutions: IF Offered treatment list includes diagnosis; THEN Put institution into short list; 3.4 Inscribe patient: IF Institution in short list AND has free capacity THEN inscribe patient; ELSE Contact next institution on short list …….

Table 1 shows the causes, the knowledge that is behind each cause and lists some of the exemplary business rules (partly in pseudo-code) that define what kind of information is needed for the final decision on the completeness of the information (see Figure 3).

B. Clustering Business Rules to Decisions

As the general business rules for the causes are known, they are clustered according to the effect that is to be achieved. In Table 2 the necessary rules are already summarized according to the analyzed effect "information needed complete". Thus, the knowledge required to decide on the completeness of the needed information, i.e. on the fulfillment of one of the causes leading to the process goal achievement, is captured in decision information cluster (see Table 2). Table 2 shows the rules that are needed to achieve effect of complete information.

TABLE II

INFORMATION EFFECT DECISION CLUSTER

Cause	Decision on/ Effect	Decision Information Cluster
1. Patient Information	Private information sufficient for treatment decision	1.3 Important patient data includes: age, gender, insurance class, medication, medical support;
2. Medical History	Medical information sufficient for treatment decision	2.3 Important medical information includes: diagnostics, current patient chart; 2.5 IF information is clear; THEN get in contact with treatment institution; ELSE contact the medical support to complement the medical information
3.Availability Information	Treatment institution is available	3.3 Get the short list of related institutions: IF short list not empty THEN check availability

Figure 4 shows the logic of the decision on the patient treatment as a business rules model. Business rules from the "information needed complete" decision point can be composed into a set that can be summarized in the rule "information harvesting" in Figure 4 and thus can be seen as one of the decision clusters.

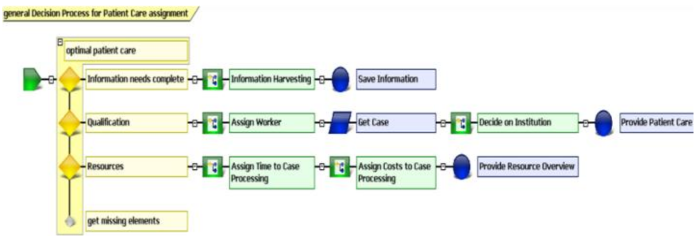

Fig. 4. Resulting decision process as business rules model

Once the information on the patient and the treatment institution is provided, a responsible worker needs to be defined to process and guide the treatment. This choice can be finally made after the information harvesting has been initiated as with different information level a different level of qualification of the operational worker is needed. To decide on the resource annotation urgency of the case needs to be known and the available resources need to be scanned. This is done in the rules: "assign costs to case processing" and "assign time to case processing" in Fig. 4. Thus, Fig. 4 shows the causes of the process goal: information harvesting, assign worker and assign time to case processing. These are further regarded as effects on a more detailed level. Their causes are used to derive accordant business rules that are cumulated to decision information clusters that will further be implemented as decision services.

C. Accumulating Decisions to Decision Services

Figure 5 summarizes the process of the operational decision making that is needed to achieve an optimal patient treatment. Each of these decision steps is regarded here as the decision information point, i.e. activities that indicate the need for information that has to be built by the process worker to enable further process flow and process goal achievement.

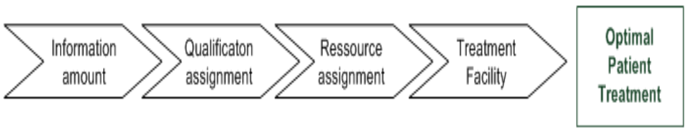

Fig. 5. Decision process towards deriving the optimal treatment

Figure 4 specifies one of these decision steps- the decision cluster concerning information harvesting. Decisions within the cluster are composed of several rules (the process itself is presented here as containing several decision points that are composed of further decisions). Each of the decision points in Figure 4 can now be realized as a service that invokes further rule services. This super-service is called here the *decision service*.

In this process three of the decision services, i.e. decision information points, were identified: Information needed, Qualification of the operating worker and Resources. The business rules modeling tool used here saves the business rules model as a XML-like data file, thus allowing an automated execution of the model as a service. Nevertheless, the identified decision services are not alone standing services. In general they intersect or are depend on each other. This fact is important for an automated implementation of these services.

The service cooperation points need to be defined, so that a decision on whether the request-reply (classic SOA integration) or publish-subscribe paradigm (often used in an Event-Driven Architecture) is more efficient for the process realization.

V. RELATED WORK

Business rules and business rules-based approach to business processes was initiated and significantly pushed forward by [16, 26]. Now the Business Rules Group develops and integrates standards as well as formulates statements referring to business rules. Extending the business rules approach [27] the Decision Model approach was developed by [27] using the combination of business logic, business decisions and technology. [7, 22] established the term “Enterprise Decision Management”, an approach that deals with business rules and their implementation into automated decision support in the enterprise. In this context a decision service is a “group of rules […] exposed in the web services layer of conventional SOA Stack” or “A service that answers a business question for other services” [22]. These definitions are also supported in this paper.

For decision identification within business processes several approaches exist. [17] suggest application of the data mining approach on process models. The authors perform a decision point analysis based on a business process model to find out which properties might lead to the choice of certain path in the process. The goal here is to find decision rules for single process paths. Therefore the authors use apart from the process model an event log produced by a process-aware information system. This approach can also be found in e.g. [13, 20].

In general, decision identification and clustering approaches reviewed in this section are not a part of the Decision Support Systems (DSS)-research, as a DSS must provide the decision maker with necessary data and information that allows him or her to identify the situation and the decision context, choose an alternative as well as to provide data analysis tools.

The cause-and-effect analysis approach chosen in this paper for business process analysis is rooted in the area of quality management. Quality management tools were often used in business process analysis from its early beginning [10]. In business process management (BPM) the orientation on final process results is also known as goal oriented BPM. This approach was established by Kueng and Kawalek in 1997 [12]. The terms goal and effect can be often used as synonyms, as both presume that human action is primary driven by achievement of results, that is goals [18] or in a broader sense - effects. Kueng and Kawalek build their goal definition on [14] where goals express intentions and capture the reasons of the system to be built. Winter et al. 1995 [32] showed that different concepts on purpose can lead to different behavioral and IT requirements.

Thus, Kueng and Kawalek [12] suggest an approach for creation and evaluation of goal-oriented business process models [12]. Later Kueng also applied this approach for conceptualization of business process performance measurement systems [11]. [3] developed the goal-oriented performance management further by introducing structural metrics for goal based business process design and evaluation. [5] introduces an agile, goal-oriented business process management approach to deal with changeability of business environment and processes. Goal-oriented approach to BPM is now also supported and developed by business application producers like e. g. [23, 31].

VI. CONCLUSION AND OUTLOOK

In this paper the cause-and-effect analysis was applied for analysis of a decision knowledge intensive process. Decision knowledge intensive processes need a significant amount of information and knowledge to support decision making. This knowledge is captured in business rules that govern the process logic. They also define or indicate the information that is needed to apply this knowledge on the specific process. The taxonomy connecting business rules, decisions and required information has been presented. Thus, business rules and policies concerning a specific operational decision can be summarized into a decision information cluster. The cluster can be further specified by decision information points on the process model level as process elements that indicate specific information need. The decision services are the implementation of the decision information clusters that are refined with the process related information. Figure 6 shows the process from the definition of the process goal of a decision knowledge intensive process to the design of the content of a decision service.

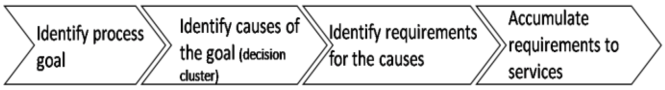

Fig. 6. Identifying decision services: process

The cause-and-effect analysis supports the analysis of decision knowledge-intensive processes, as it aims at the basis of the decision, its causes and consequences. Applying this approach resulted in a clear decision structure (see Figures 4 and 5) containing decision elements that were called decision services as they can be implemented as separate software elements in a service-oriented architecture. These services contain several business rules that can be modeled and transformed into a software code. Thus, a deductive approach to decision and business rules identification and implementation is used here. Identifying the process goal and its causes leads on a more detailed level to the identification of the conditions of these causes that lead to the atomic structure of business rules that can be accumulated to executable software elements - the services. This approach can be used for business rules identification and decision making as it has been shown that operational decisions are taken with high process proximity thus involving process-related business rules. Furthermore, using the graphical representations of business rules models facilitates the management of business rules as changes in the single rule can be implemented using the graphical business rule model. Beside the business process analysis aspect, an approach to cluster business rules into decision services was shown, that allows an effective implementation of automated decision management into application architecture and accordant business process. Decision services can be captured in a Business Process Management System that has a business rules management component or is based on service-orientation. Thus, our future work will include implementation of the identified decision services into a workflow system that supports decision knowledge intensive processes.

REFERENCES

1. **Anthony, R.N.** Planning and Control Systems: A Framework for Analysis. Harvard University, Boston, USA, 1965.
2. **Aurum, A., Wohlin, C**. The fundamental nature of requirements engineering activities as a decision-making process. **In**: *Information and Software Technology*, 45(14):945_954, 2003.
3. **Balasubramanian, S., Gupta, M.** Structural metrics for goal based business process design and evaluation. **In**: *Business Process Management Journal*, 11(6):680_694, 2005.
4. **Bromberg, D.** BPM for knowledge workers inside decision intensive processes (DIPs): Knowledge, practice, context, and characteristics. BPTrends, February, 2007.
5. **Burmeister, B., Arnold, M., Copaciu, F., Rimassa, G.** BDI-agents for agile goal-oriented business processes. **In**: *Proceedings of the 7th international Joint Conference on Autonomous Agents and Multiagent Systems: Industrial Track*, pp. 37-44. International Foundation for Autonomous Agents and Multiagent Systems, 2008.
6. **Business Rules Group**. The business rules group: Defining business rules - what are they really?, 2006
7. **Cutter Consortium** Enterprise decision management | cutter consortium. Webpage, January 2005.
8. **Champy J., Hammer, M.** Reengineering the Cooperation: A Manifesto for Business Revolution. Harper Collins Publisher, New York, 1993.
9. **Ishikawa, K.** Introduction to Quality Control. Quality Resources, 1990.
10. **Kettinger, W.J., Teng, J.T.C.** Business process change: a study of methodologies, techniques, and tools. **In**: *MIS Quarterly*, 21:55-80, 1997.
11. **Kueng, O.** Process performance measurement system: a tool to support process-based organizations. **In**: *Total Quality Management*, 11(1):67-85, 2000.
12. **Kueng, P., Kawalek, P.** Goal-based business process models: creation and evaluation. **In**: *Business Process Management* Journal, *3(1):17*-38, 1997.
13. **Kusiak, A., Kern, J.A., Kernstine, K.H., Tseng, B.T.** Autonomous decision-making: a data mining approach. **In**: *IEEE Transactions on Information Technology in Biomedicine*, 4(4):274-84, December 2000.
14. **Loucopoulos, P., Karakostas, V.** System Requirements Engineering. McGraw-Hill, London., 1995.
15. **Papazoglou, M.P., Georgakopoulos, D.** Service-oriented computing. **In**: *Communications of the ACM*, 46(10):25_30, October 2003.
16. **Ross, R.** Principles of the Business Rule Approach. **In**: *Management Information Systems*. Addison- Wesley, 2003.
17. **Rozinat, *A*., van der Aalst, W.M.P.** Decision mining in PROM. **In**: *Business Process Management*, pp. 420-425, 2006.
18. **Scherer, E., Zoelch, M.** Re-engineering the Enterprise. **In**: *Proceedings of the IFIP TC5/WG5.7 Working Conference*, Galway, Ireland, 20-21 April *1995*, *C*hapter*:* Design of activities in shopfloor management: a holistic approach to organisation at operational business levels in BPR projects, *pp*. 261-272. Chapman & Hall, London, 1995.
19. **Schroepfer,*Chr.*, Schoenherr, *M.*** Introducing a method to derive an *enterprise-specific SOA* operating model. **In**: *12th International IEEE Enterprise Distributed Object Computing Conference, EDOC '08*, pp. 235-244. IEEE, 2008.
20. **Smirnov, *A.*, Pashkin, *M.*, Levashova, *T.*, Shilov, *N.*, Kashevnik, *A.*** Role-based decision mining for multi-agent emergency response management. **In**: *Autonomous Intelligent Systems: Multi-Agents and Data Mining*, *(*4476*)*/2007 of Lecture Notes in Computer Science, *pp. 178*-191. Springer Berlin, 2007.
21. **Innovations Software**. Visual rules modeler, 2010.
22. **Taylor, J., Raden, N.** Smart Enough Systems: How to Deliver Competitive Advantage by Automating Hidden Decisions. Prentice Hall PTR, 2007.
23. **Tibco**. Goal-oriented business process management creating agile business processes for an unpredictable environment. Technical report, Tibco, 2007.
24. **Trier, M., Müller, C.** Towards a systematic approach for capturing knowledge-intensive business processes. **In**: *Practical Aspects of Knowledge Management*, pp. 239-250. Springer, 2004.
25. **van Aken, J. E.** Management research based on the paradigm of the design sciences: The quest for field-tested and grounded technological rules. **In**: *Journal of Management Studies*, 41(2):219-247, March 2004.
26. **von Halle, B.** Business Rules Applied. Wiley & Sons, 2002.
27. **von Halle, B., Goldberg, L.** The Decision Model: A Business Logic Framework Linking Business and Technology. Auerbach Publications, 2009.
28. **Goldberg L., Zachman J., von Halle, B.** Business Rule Revolution. Running Business the Right Way. Happy About, 2006.
29. **World Wide Web Consortium** (W3C). Web services architecture, 2004.
30. **Taveter, K., Wagner, G**. Agent-oriented enterprise modeling based on business rules? **In**: *20th Int. Conf. on Conceptual Modeling* (ER2001), Yokohama, Japan, 2001. Springer Verlag.
31. **WhitesteinTech**. GO-BPMN: Goal-Oriented Business Process Modeling Notation. Technical report, Whitestein Technologies AG, 2007.
32. **Winter, M., Brown, D., Checkland, P.** A role for soft systems methodology in information systems development. **In**: *European Journal of Information Systems*, 4:130_142, 1995.

Olga Levina received the Diploma (Master equivalent university degree) in Industrial Engineering and Management with focus on Information and Communication Technology at Berlin Institute of Technology in 2007. She also studied economics and management at the LUISS University in Rome.

She was student research assistant at the Fraunhofer Institute for Manufacturing and Production Technology and currently since 2008 works as Research Assistant and PhD student at the Department of Systems Analysis and IT at Berlin Institute of Technology. Her research interest lies in quantitative analysis of business processes, business rules as well as in service- and event-oriented business process automation.