Pattern-based Process Weakness Analysis for Public Administrations

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Abstract: The improvement and optimization of business processes is of great importance for public administrations. While conceptual models are widely used as information basis for this task, the analysis of the processes itself is still mainly performed manually. This paper aims to address this by presenting a pattern-based approach for the weakness analysis of public administration processes based on the domain specific modeling language PICTURE.

1 Introduction

Business Process Management (BPM) was and still is an important topic for public administrations in general and specifically in the context of eGovernment [WS11]. Thereby, IT technologies should be applied to make public administrations processes more efficient [ZFL10]. Nevertheless, any investment in IT to support a business process requires detailed analysis beforehand [KTG97].

Usually, conceptual modeling techniques are applied to capture information about the processes of interest and supply the information for such an analysis [PW03]. However, the analysis itself is widely considered to be rather an art than a science [LR07] and is performed mainly manually [VTM08]. Hence, methodological support for this phase is mainly limited to the application of generic creativity techniques [Ze11] and the suggestion of common best practices [LR07].

This paper aims at closing this gap by presenting an approach for a pattern-based weakness analysis for semantic process models. The presented approach is based on the domain specific semantic process modeling language PICTURE [BAPR07, BAF07] and prior work on pattern analysis [BBBR12, BBKP08]. In contrast to these papers which focus on a technical architecture and the evaluation of patterns based on project data, this contribution aims at giving an overview over the whole pattern-based analysis approach. To this end, section 2 outlines related work on process analysis, process weaknesses and PICTURE. In Section 3 the conceptual constructs of the suggested approach are
presented along with instantiations in form of concrete patterns and a procedure model for the application of the approach. Section 4 summarizes and discusses the contributions of this paper.

2 Related Work

2.1 Business Process Redesign and Business Process Analysis

Business Process Redesign is a central part of BPM concerned with the improvement of business processes either through radical change or continues improvement [VG99, Ze11]. Kettinger et. al. [KTG97] formulate the typical activities within Business Process Redesign in a six step framework: Envision, Initiate, Diagnose, Redesign, Reconstruct and Evaluate. The approach presented in this paper addresses especially the Diagnose stage, the analysis of business processes for potential weaknesses and improvement potentials.

In this analysis phase, business process models are widely used to capture information about the underlying process and serve as basis for the analysis itself [Aa07, VTM08]. In literature, a significant number of techniques to support the analysis of process models are suggested for different problem areas. Process verification examines if a process model is correct, i.e. that it exhibits properties like soundness or the absence of deadlocks and lifelocks [Aa97, VAH07]. Process validation, on the other hand, verifies that a process behaves as expected, e.g. be replaying example cases [Aa07]. Other approaches focus on the support of the management of large collections of data, e.g. by identifying similar models [DDO08, KWW11], by merging two models [MS06] or by identifying important components of a model [PSW08]. Process simulation can support a quantitative analysis of business processes e.g. regarding throughput times or resource utilization [Gr03]. However, it is also criticized for the effort to create suitable models [Gr03, VW00], often leading to the usage of simplified, unrealistic models.

These techniques support the analysis of business processes in constructing and maintaining an accurate, high quality model base. Furthermore, simulation allows also for the comparison of as-is and to-be models [AEGN02, Aa98]. However, they do not directly support the task of identifying weaknesses and improvement potentials in business process models directly. This is still regarded as a creative task which is preformed mainly manually by an analyst [LR07, VTM08]. Accordingly, it is mainly supported through general creativity techniques like brainstorming, cause-effect diagrams or creativity-silence workshops [KTG97, Ze11]. In addition to this, Liman Mansar and Reijers present a set of best practices, which can be applied in the context of Business Process Redesign [LR07]. However, these best practices focus more on supporting the Redesign phase than the Diagnose phase. This paper aims to addresses this gap by suggesting a model based approach for the identification of weaknesses in business processes specifically for public administrations. Relations between such weakness and best practices are studied in [BBBR12].
2.2 Processes Weaknesses in Public Administration

The BPR and organization literature discusses a number of possible weaknesses a process can exhibit and, hence, make it a possible subject for reorganization measures. Among those mentioned regularly are multiple data entries and redundant data, long waiting and idle times, unproductive activities, e.g. in form a excessive control activities or redundant work steps, complex processes spanning multiple organizational units, and extensive information exchange as well as information deficits [Da93, HC93]. Furthermore, information technology is identified as an important enabler for the reorganization of problematic processes, e.g. through the automation or at least by supporting certain process steps or by capturing and providing information [Da93, HC93].

For the public administrations, there is evidence that some of these generally accepted weaknesses are also typically found in this domain. A study in multiple public administrations in Germany revealed that across the studied 23 processes, similar weaknesses could be identified [ADN05]. The study identified media breaks, redundant process steps, e.g. due to missing information and redundant data, missing software functionality and automation potentials, as well as organizational breaks and barriers as common problems across different public administration processes.

Thus, to support the analysis of public administration processes, such weaknesses have to be identified in process models. To this end, a suitable modeling approach is needed.

2.3 Semantic Modeling with PICTURE

PICTURE is a modeling methodology developed specifically for public administrations. It is designed to support the modeling of the whole process landscape of an administration and, hence, facilitates the analysis of process models especially regarding reorganization potentials [BAPR07, BAF07]. In the following, the core constructs needed in this paper are explained.

The central construct of PICTURE are so called process building blocks (PBBs). They represent activities within public administration processes. Here, PICTURE is distinguished from general applicable modeling methods like BPMN or EPC as it provides a fixed set of PBB types instead of generic constructs like functions or activities. Examples for PBB types are “Create Document”, “Enter Data into IT” or “Print”. Furthermore, each PBB of a certain type has a specific set of attributes, e.g. “Number of Printed Pages” for “Print” or “Execution Time” for “Enter Data into IT”. Furthermore, PICTURE allows for the modeling of the organizational structure, the resources needed for processes steps as well as the consumed and produced information (e.g. documents) in separate views. The elements from these views can also be annotated to PBBs.

The use of PBB types and associated attributes eliminates the need for natural language processing of activity labels when analyzing the process models [BBBR12]. Thus, the
domain semantics captured in the PBBs can be leveraged to the analysis level to formulate weakness patterns.

3 Pattern-based Weakness Analysis

3.1 Concept of a Pattern

The goal of a pattern is to formalize certain properties of interest in conceptual models by describing reoccurring structures of model elements [Pf08, TLR07]. Hence, a pattern itself is a model which makes use of the elements of the modeling language. In the case of this paper, such model elements are particularly PBBs and their attributes. The public administration domain semantics captured within PBBs allows creating patterns which in turn incorporate knowledge about weaknesses in the domain. To create weakness patterns, the following pattern elements are used.

- A required PBB is used to describe that a PBB of this type must occur in a process for it to match the pattern.

- A wildcard between two required PBBs indicates that a number of PBBs can be skipped in the process models between the matches for the two required PBBs. For computational reasons, this number can be limited.

- An attribute condition can be annotated to required PBBs, thus, allowing to specify further conditions besides the type for a model PBB to match. It consists of a comparison operator and a comparison value.

- A parameter condition allows setting parameters for required PBBs regarding annotated elements from other views. Thus, it can e.g. be specified, that two PBBs have to operate on the same (or different) documents without specifically naming a document instance.

A match for a pattern in a process model is found, if the required PBBs of the pattern are found in in the specified order, fulfilling all attribute and parameter conditions. PBBs in the process model can be skipped, if specified by a wildcard in the pattern.

3.2 Formalizing Weaknesses as Patterns

After introducing the conceptual elements which can be used to build a weakness pattern, in the following a set of patterns for the weakness analysis in public administrations is introduced. To this end, four different types of weaknesses are distinguished: media breaks, information deficits, automation potentials, and organizational breaks.

Media breaks occur, if the medium carrying information changes during the course of a process execution, e.g. through printing, scanning or manually entering data into a
system. This is normally requires a substantial amount of work and is a potential source of erroneous or inconsistent data, and hence regarded as problematic in processes.

Due to the semantics included in PICTURE PBBs, some forms of media breaks can be formalized using simple patterns. The media breaks scanning, printing and manually entering data correspond to PBBs of type “Scan”, “Print” and “Enter Data into IT”, respectively and thus can be represented with pattern consisting of only one PBB (cf. Figure 1, 1-3). Media breaks for incoming and outgoing information can be formalized with PBBs “Receive Document/Information” and “Send Document/Information” with the additional use of the “Channel” attribute to identify non-electronic communication (cf. Figure 1, 4 and 5a).

Though these patterns specify certain types of media breaks, they can be too coarse in certain situations, e.g., if certain media breaks are due to legal regulations. In this case, more complex and restrictive patterns can be used. The additional attribute “Recipient” can be used to narrow sending down to internal or inter-authority sending, were legal reasons might not inhibit a switch to electronic channels (cf. Figure 1, 5b). Furthermore, more complex patterns using multiple PBBs, wildcards and parameters conditions can be used to identify situations where incoming documents are manually entered (presenting a potential for online forms) or printed for (internal) sending, which could be avoided using a DMS or at least email (cf. Figure 1, 6 and 7).

Figure 1. Weakness Patterns for Media Breaks
An information deficit occurs if missing information prohibits the further execution of a process. Research activities or inquiries involving internal and/or external partners are necessary to acquire this information. This is deemed problematic as it can bind resources and stop the process instance for an uncertain amount of time. Also, the involvement of third parties can lead to additional coordination efforts.

Similar to media breaks, some information deficits can be captured with simple patterns. Again, investigations and inquiries have corresponding PBBs “Perform an Investigation” and “Make Inquiry” which constitute the respective patterns (cf. Figure 2, 1-2). More complex patterns can be applied to identify verifications which lead to inquiries, indicating insufficient supplied information, and formal checks were the supplied information is incomplete and, hence, further documents have to be requested (cf. Figure 2, 3-4). In the former pattern, deliberately no wildcard is used as it is assumed that the activities directly follow each other. The later pattern applies multiple attribute conditions to identify the checks of interest. The 30% negative results are just an orientation point to describe a substantive amount of failed checks.

![Diagram of Weakness Patterns for Information Deficits](image)

Figure 2. Weakness Patterns for Information Deficits

Automation potentials capture situations in which certain standardized activities could be better supported or automated through the use of IT. The lack of proper IT support could lead to problems like additional working efforts as well as possible errors and lacking standardization in the work results.

Automation potentials are formalized using PBBs and according attributes which indicate poorly supported manual activities. This includes specific PBBs like “Perform Calculation”, “Create Document”, or “Archive Document”, where no dedicated systems are annotated. The corresponding patterns make use of the hierarchical classification of resources like software in the resource view of PICTURE (cf. Figure 3, 1-3). Furthermore, certain media breaks and information deficits also present automation potentials. The use of standard, non electronic fax can, e.g., be supported through an electronic fax solution (cf. Figure 3, 4a and 4b), while researching for legal information can be supported with legal information systems (cf. Figure 3, 5).
Organizational Breaks occur at interfaces if multiple organizational units are involved in a process. Possible problems include long transport or idle times, high coordination efforts or duplicate activities due to deficits in the division of labor. Furthermore, media breaks often occur at these interfaces. Subsumed under this category are also interfaces to external process participants like other authorities or customers.

A typical simple pattern found at organizational breaks is an unproductive activity like the pure sighting of documents (usually through superior officials). It can be formalized using a single PBB (cf. Figure 4, 1). Generally, internal organization breaks can be identified by different organizational units annotated to PBBs within a single process (cf. Figure 4, 2). A problematic external contact due to unclear information sent out to a customer can be formalized by using the PBBs for sending and consultation with a wildcard in between (cf. Figure 4, 3).
be further adjusted through the use of additional attribute conditions like explained in the case of non-electronic internal sending.

3.3 Assessing Improvement Potentials

The identification of a process weakness leads inevitably to the question, how this weakness can be addressed. Besides purely organizational measures like changing responsibilities for or the order of tasks, investments in IT, like DMS or WFMS, are a common solution to overcome weaknesses like, e.g., media breaks. However, the benefits of such an investment have to justify the costs associated it.

Based on the identified pattern matches, a simple heuristic can be applied to roughly estimate possible benefits of a certain improvement measure. It is based on the following elements:

- **Key Figure**: A key figure is based on the attributes of the model elements (PBBs, sub-processes, etc.) identified in a pattern match. It represents a figure that will be influenced by an investment. Hence, a key figure is specific for a pattern in combination with one or more reorganization measures. A simple example for a key figure for the pattern “Printing for Non-electronic Sending” in combination with the introduction of a DMS would be “Printed Pages per Year” as product the attribute “Printed Pages” of the “Print”-PBB and process attribute “Executions per Year”.

- **Savings Rate**: The savings rate estimates the influence of an improvement measure on a key figure in monetary terms per key figure unit. For a more detailed calculation, it can be broken down into two parts: a cost rate and a percentage rate which estimates the percentage change of the key figure. In the printing example, the cost rate could be 0.10 EUR per printed page. Furthermore, it could be estimated that the introduction of a DMS reduces the key figure “Printed Pages per Year” by 50% (e.g. because in the other cases the printing is required by law). This would result in an improvement potential of 0.50 EUR per printed page per year.

This way of assessing improvement potentials based on pattern matches in all process models has the benefit of considering the whole process landscape and not only a single process. Hence, it is especially beneficiary for cross-organizational measures like the introduction of a DMS. IT of this kind will often provide benefits for a large number of processes. However, the benefit for a single process alone might not sufficient to justify the investment costs. Only when considering multiple processes, as done by the pattern based analysis, the benefit of such an investment justifies its costs. Nevertheless, such a calculation only provides a rough estimate of an improvement potential and depends on a good estimation of the savings rate.
3.4 Applying the Weakness Pattern Approach

In this section, a short 6-step procedure model for the application of the pattern-based weakness detection is presented.

**Step 0 – Model the process landscape:** Before any analysis work can be done, the relevant processes need to be modeled. Previous research has shown that weaknesses across public administration processes, even from different functional units, are similar [ADN05]. Hence, a large model basis is useful to detect similar weaknesses across different processes.

**Step 1 – Identify weaknesses of relevance:** Although it is possible to search all weakness patterns in the model base, normally the analysis will focus on a particular type of weakness, possibly with a certain IT technology like DMS or WFMS as remedy in mind.

**Step 2 – Choose and adjust weakness patterns:** Based on the weaknesses of interest weakness patterns are chosen. Depending on the goals of the analysis, they are adjusted, e.g. to be more coarse or more restrictive (as elaborated in 3.2). Furthermore, the attributes maintained in the model basis also have to be considered here.

**Step 3 – Search the model basis:** In this step, pattern occurrences are searched in the model base by a modeling tool implementing the pattern matching approach. The tool returns all matches for the patterns.

**Step 4 – Validate pattern matches:** The matches returned by the pattern approach should be manually inspected by a process analyst to ensure that they represent real weaknesses. Matches which are no weakness or cannot be changed, e.g., due to legal restrictions, are omitted from further analysis.

**Step 5 – Assess the improvement potential:** Based on the set of identified weaknesses, the improvement potential, e.g., through the application of technology like DMS or WFMS can be assessed as explained in the previous chapter.

4 Discussion and Conclusion

In this contribution, an approach for the detection of process weaknesses in public administrations was presented. This paper laid the focus on a presentation of the approach from a holistic conceptual perspective. It provides the conceptual basics of the pattern matching approach together a concrete set of patterns, a simple assessment method and a procedure model to apply the approach. Due to this conceptual focus, an evaluation as well as implementation details were not in the focus of this paper.

In this paper, the PICTURE modeling language was used as basis for the formalization of weakness patterns, as it provides the necessary domain semantics in form of PBBs. Furthermore, a prototypical implementation of the approach exists for this language [BBKP08]. Thus, this approach is in so far limited to the application with such a domain
specific modeling language as it relies on the concept of PBBs to capture domain semantics. However, if such domain semantics are included into other, general-purpose modeling languages – e.g. into BPMN activities – the approach could also be transferred to these modeling languages.

Even though an evaluation is out of the scope of this paper, a first study based on real data, where weaknesses were derived from interviews with officials, shows that the formalization of weaknesses as suggested in this paper can be successfully applied [BBBR12]. However, further evaluation is different projects is needed and will be the subject of future research.

References


