Domain Specific Process Modelling in Public Administrations – The PICTURE-Approach

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Abstract. In this paper a domain specific process modelling method for public administrations is presented. The public sector is facing an increased service level demand from citizens and companies which comes along with reduced financial scope. Higher process efficiency as well as time and cost savings are required to cope with this challenge. However, reorganisation projects in public administrations with established generic process modelling methods could only identify limited reorganisation potential and just led to small local improvements [1]. Therefore, we have created the domain specific modelling approach PICTURE. The PICTURE-method applies the domain vocabulary to efficiently capture the process landscape of a public organisation. Thus, PICTURE creates process transparency and is able to detect holistic reorganisation potentials within the entire administration.

Keywords: Domain Specific Modelling, E-Government, Process Building Blocks, Public Administration, Process Landscape.

1 Process Modelling in Public Administrations

Process models have been established as a broadly applied instrument in Business Process Management [2-4]. They are used to explicate the implicit knowledge of an organisation by modelling the processes and thus, lead to improved transparency.

Public administrations are facing specific conditions when they model their business processes and try to improve them. The common public administration service portfolio is much diversified and complex [5]. Municipal processes include more than 1,000 interconnected and interdependent services and underlying processes for citizens, companies, and other administrational parties [1]. Simultaneously, public administrations are large organisations with decentralized knowledge about the processes. Usually, there is no organisational unit that has detailed expertise about the entire process landscape. New challenges like cost reduction and an increased service level demand from citizens and companies induce reorganisation pressure on the public administrations [6]. In order to be able to timely implement changes in the organisation an overview about the actual process structure is required.

So far process modelling in public administrations has mainly been performed with generic (general-purpose) languages [1, 6]. These modelling languages, such as Activity Diagrams (AD) [7], Business Process Modelling Notation (BPMN) [8], or

M.A. Wimmer, H.J. Scholl, and A. Grönlund (Eds.): EGOV 2007, LNCS 4656, pp. 68–79, 2007.

Event Driven Process Chains (EPC) [9], are flexible instruments to describe diverse processes in many different domains. However, they do not consider in particular public administration and reorganisation specific questions like: (1) how can a very large number of processes be acquired efficiently, (2) what changes have what impact on the process efficiency, or (3) what processes, activities, or products depend on which legal regulations [10, 11]? This results in the conclusion that these generic approaches are not suitable to represent all relevant aspects of this domain. Therefore, there is a need for a new, administration specific modelling language.

In this paper we present the process modelling method PICTURE that has been developed to address the specific conditions of reorganisation projects in public administrations. PICTURE allows for an efficient modelling of the entire process landscape of an organisation. Thereby, the specific information which is relevant for a reorganisation project can be collected. This overall view allows for reorganisation decisions that are based on the consideration of structural analogies, potential synergy effects, and economies of scale. PICTURE takes the particular legal and political constraints within public administrations into account and indicates technical and organisational measures to improve the efficiency of the process landscape.

The remainder of this paper proceeds as follows. Firstly, based on the specific characteristics of the public sector, requirements for an administration specific process modelling method are defined. Subsequently, the PICTURE-method is described as a core contribution, which works to efficiently capture the process landscape of public administrations. Afterwards, the utility of the method in modelling projects at the University of Münster and at the City of Münster is illustrated. The paper closes with a summary of the results and an identification of further research.

The research method being used for developing the PICTURE-approach is based on the work from Takeda et al. [12], Song and Osterweil [13], and Avison et al. [14]. The work belongs to the design-science oriented research [15].

2 Requirements of a Domain Specific Modelling Method

Domain specific modelling methods have gained a lot of attention in the information systems community during recent years [16, 17]. Contrary to general-purpose methods, domain specific methods are created to solve problems within a particular area of concern [18]. They apply the specific vocabulary of a domain in order to describe this part of reality. As the constructs of a domain specific method come from the domain vocabulary, the domain experts understand the meaning of the constructs and are able to adequately apply them.

A domain specific method for public administrations must consider the particular characteristics of this field. The following requirements reflect the application area of a method for public administrations in the context of process reorganisation [19]:

1. *The modelling method allows for a simple representation of the process landscape.* To model the whole process landscape of a public administration with acceptable efforts a simple language is required. If a generic modelling method is used the meaning of the constructs is mainly not intuitive and their counterparts in the real world are hard to identify. However, even knowing which modelling language constructs to pick in a certain situation does not imply the knowledge of how to

combine them. Therefore, the syntactical rules of a modelling language must also be easily comprehensible. A less complex, domain specific language is easier to learn and thus, allows for more efficient modelling as all constructs are pre-defined with meanings of the application domain. Simultaneously, however, the domain specific modelling language has to be powerful enough to gather all relevant aspects of the processes.

2. *The modelling method allows for the creation of maintainable process models*. Especially for usage scenarios within administrations, such as a model-based knowledge-management, maintenance of information technology, or continuous improvement of the business processes, actual models of the processes are important. To make sure that the process models are always up to date, the maintenance of the models has to be achievable with minimal efforts. As the modelling of processes is not the main business of officials in a public administration the models should be less complex and easy to grasp.
3. *The modelling method allows for the creation of comparable process models.* The inherent structural analogies within and between public administrations offer a high potential for reorganisation. Therefore, it is not sufficient to analyse the process models of an organisation independently from each other. It is important to identify similar or deviating structures in the models [20]. Thus, the models must be syntactically and semantically comparable. However, if two models are compared, type conflicts, naming conflicts and structural conflicts can arise [21]. *Type conflicts* occur whenever the same fact of an application domain is represented by using different constructs of a modelling method. *Naming conflicts* emerge due to the use of synonym and homonym terms in conceptual models. *Structural conflicts* result from a description of reality at diverse levels of abstraction (abstraction conflict) or whenever domain terms are modelled differently detailed (conflict of detail) [20]. To get comparable process models in this way, the degree of freedom for the modellers has to be limited. The modelling method itself should ensure that the same issue in two different cases and considered from two different persons is modelled the same way [22].
4. *The modelling method allows for the (semi-)automatic analysis of process models.* An examination of a single process facilitates the identification of weaknesses that are specific to this particular process. However, in order to discover the overall reorganisation potential it is not sufficient to analyse only the current state of a single process, but an examination of the process landscape is required. Analysing the whole process landscape of a public administration means working with a large set of data. Therefore, it is necessary to provide mechanisms within the method which allow for automatic or semiautomatic analysis of the data. Analyses of process models are made for measuring weaknesses as well as reorganisation potential. An example is the identification of so called „Ping-Pong"-processes. By counting the alternations between organisational units within the models these weaknesses can be identified, even in an automatic way.
5. *The modelling method allows for efficient modelling*. The collection of the process landscape of an administration requires not only a large modelling team but also the inclusion of many domain experts. Therefore, the modelling method has to create as little efforts as possible while gathering the process models within the public administration.

3 The PICTURE-Method

The PICTURE-method consists of a modelling language and a procedure model which guides the application of the language. Both parts are implemented in a web-based tool with the name PICTURE. After describing the PICTURE-language with its main constructs, the procedure model is explained.

3.1 The PICTURE Modelling Language

Basic construct of the PICTURE modelling language is the so called process building block. A process building block represents a certain set of activities within an administrational process [23]. Some examples of process building blocks are shown in Table 1.

Table 1. Examples for process building blocks with their specification

Process Building Block	Definition of the Process Building Block
Incoming Document	A document which arrives from an internal or external source.
Create Document	A new document is generated.
Print Document	A document is outputted with a printer.
Formal Assessment	A proposal is formally assessed and a decision is reached.
Enter Data into IT	Facts or documents are manually entered into an IT system.

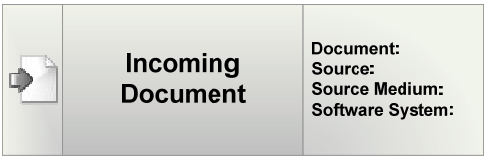

Fig. 1. The Process Building Block "Incoming Document"

The PICTURE process building blocks have been specifically developed for public administrations and apply the vocabulary of this domain. As they are domain specific the meaning of a process building block is characterised by a corresponding domain statement. Hence, process building blocks dispose of a fixed, informally defined, domain specific semantics. Contrary to constructs of traditional process modelling approaches like activities in an AD or functions in an EPC, process building blocks in PICTURE reside at a particular level of abstraction. For example a function in an EPC can be instantiated as: "Waiting for document", "Receiving application form via letter", or "Signing the labour contract". These functions stand for differently abstract phenomenon in the real world. However, an instance of a process building block, for example "Incoming Document" (cf. Fig. 1), has always a specific meaning, in this case that a document arrives. The meaning is inherently pre-defined for this building block and is not specified by the modeller.

Table 2. Examples for attributes including their definitions

Attribute	Definition of the Attribute
Document	The name of the document which is moved or processed. For example an application form or an official notification.
Source	Source of a document or information, e g. a person, organisational unit or organisation.
Source Medium	The medium in which a document or information arrives. For example telephone, fax, mail or e-mail.
Processing Time	Time in minutes it takes to complete a certain activity.
Software System	The name of the software system which is involved in this activity.

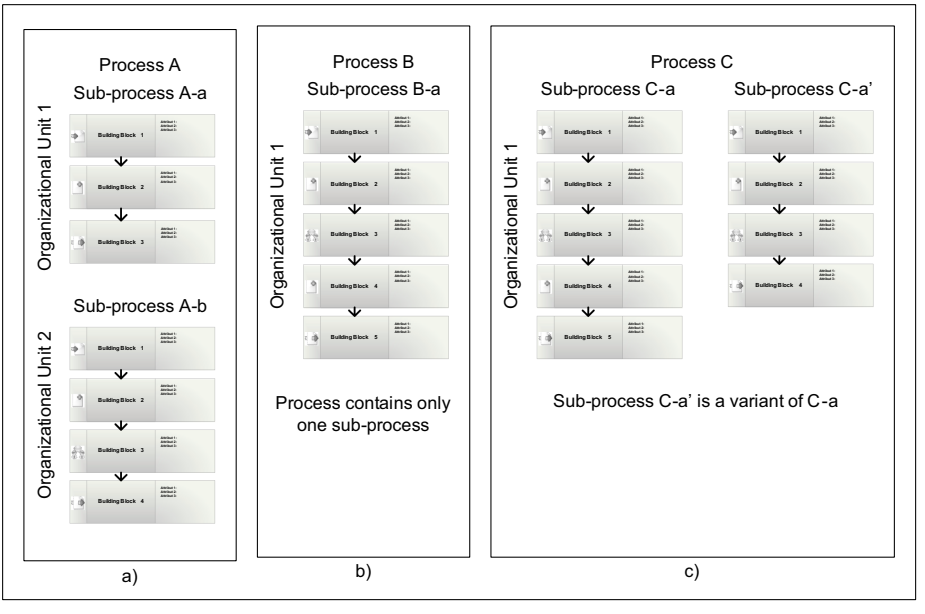

Fig. 2. Processes, sub-processes and process variants

In PICTURE the process building blocks are the only way to describe the administrational processes. This simple syntax makes the modelling easy for the method's users. Furthermore, processes are represented as a sequential flow of building blocks. Also this syntactical restriction guides the method's user and simultaneously promotes the construction of structurally comparable models. Since only process building blocks can be used, the type of each model element is not just syntactically but also semantically fixed. Problems like *naming conflicts* in a model comparison are avoided, because the name of a process building block is specified by the language designer rather than the modeller. However, the modeller is allowed to fill a text field with additional information about a certain process step. These comments are not considered during the analysis.

With building blocks the sequential order within administrational processes can be specified. However, in order to identify reorganisation potential this information is not

sufficient. Additional facts about the processes can be collected with the help of attributes assigned to the process building blocks. For example possible attributes for the process building block "Enter Data into IT" are "Source", "Source Medium" or "Processing Time" (cf. Table 2). Attributes provide the core information for a subsequent process analysis, in which, according to predetermined goals, corresponding weaknesses and potentials are detected.

As processes in public administrations run mainly decentralised in responsibility of several officials the modelling efforts for collecting the whole process have to be distributed. To address this problem, in PICTURE a process can consist of several sub-processes (cf. Fig. 2 a)). A sub-process is a process section being carried out by a responsible official or a position within a single organisational unit. Sub-processes can be linked together to visualise a whole process. The majority of the modelling activities take place on the sub-process level. In this way the modeller has to collect all the relevant information from his local view on his part of the whole process. An example is the "building permission" which has sub-processes "comments of the environments-office" or "monitoring of the building-phase" with different responsibilities. However, some processes contain only one sub-process (cf. Fig. 2 b)). An example is the process "Notification on fees for a motor vehicle". The modelling with the PICTURE-language is strictly sequential. PICTURE offers no language constructs to represent forks in the course of process building blocks. It is also not possible to model iterations. To describe technically important ramifications in the process flow, PICTURE offers two different ways: On the one hand attributes can be used to specify different cases with percentage values. For example an incoming document can arrive in 50% of the cases through the communication medium mail, in 30% per email, and in 20% per fax. On the other hand it is possible to specify process variants (cf. figure 2 c)). A process variant defines an alternative sequence within a sub-process. Process variants contain, in comparison with the original sub-process, many common process building blocks. However, some of the process building blocks have been modified, new ones have been added and some have been removed. The frequency of a process variant can be weighted by percentage values.

3.2 The PICTURE Procedure Model

The procedure model of the PICTURE-approach contains three steps. In the first step the PICTURE-method is adapted to the specific characteristics of the project. In the second step all relevant data is acquired by using the modelling language. In the third step this data is analysed in order to prepare reorganisation projects and to identify savings potential.

The first step during an application of the PICTURE-method is to define the objectives of the project. In order to collect only information which is needed for the subsequent analysis (cf. requirement 5: efficient modelling) the PICTURE-method can be customised for the specific properties of a project. The PICTURE-method comes with a list of possible project goals such as "Development of an organisation wide IT strategy" or "Implementing an organisation-wide document management system", or "Systematic identification of media breaks". The selection of appropriate objectives is performed in a goal-finding workshop together with the users of the models. This approach improves the acceptance-rate of the following modelling project as the users have already been involved in the pre-project-steps. If for example

the project goal is reorganisation then it is important to acquire the duration of activities. If the objective is to define a new IT strategy it is essential to document the existing software systems that support the processes. The configuration of the method results in a choice of the attributes which are required in order to meet the information demand derived from the project goals. Before PICTURE can be applied it is essential that the project objectives are communicated within the organisation and the project is supported by management and staff.

The second step of the PICTURE-approach is to model the entire process landscape. Therefore, modelling teams must be established and modelling orders have to be assigned. PICTURE focuses on a strong involvement of the officials of an administration in the modelling project. There are certain questions for example about the execution of processes and the frequency of certain tasks that can only be answered by a responsible official or his supervisor. Due to the fact that in order to represent the entire process landscape many officials must participate, the collection of the processes is very time consuming. It is a main contribution of the PICTURE-approach to enable modelling in a distributed manner. The collection of the process models must be performed in a coarse granular form to reduce time and efforts for modelling. The method supports the illustration of mutual dependencies between process models. The mechanisms of the PICTURE-approach allow for independent and local modelling activities.

The third step is to analyse and use the process models. In a complete acquisition and structuring of all administration processes lies an added value, since it fosters transparency. The PICTURE-method supports cataloguing the processes according to different criteria. Possible features are the structural organisation of an administration as well as a list of services. The presentation of a structural organisation is often comparatively easy because an existing administration organisation plan gives good guidance. In contrast to that, there is often no reference for a compilation of a catalogue of services. Based on the process models covering the entire process landscape PICTURE supports the development of a catalogue of services. The PICTURE-tool allows for a publication of this catalogue on the internet or the intranet. The online catalogue can be used for internal knowledge transfer to new officials or as external knowledge-base for citizens and other stakeholders.

The current state of the process landscape documented by the models can indicate reorganisation potential. For example the number of printed pages in an organisation per year, the travel time of the officials or the amount of work interruptions influences the organisation's efficiency. If these attributes are included the models critical processes can be tracked down and analysed in detail. The holistic overview shows saving potentials no longer only for single organisational units like departments or offices but for the whole administration. Additionally, by defining certain patterns of process building blocks frequent interdependencies between departments (so called ping-pong processes) can be discovered or unnecessary media breaks can be detected. An example for such a pattern is if in one sub-process a building block "Print Document" is found. In the subsequent sub-process there exists a building block "Enter Data into IT" for the same document. This could indicate an unnecessary media break and could be the starting point for an in-depth analysis as part of a reorganisation project.

Beneath organisational measures the reorganisation potential of IT basic components like document management systems, knowledge bases or virtual post offices can be estimated. IT basic component can supersede certain activities in processes or change the sequence of activities. For example the process building block "Enter Data into IT" can be removed without substitution if a document management system provides the same information electronically. As the PICTURE-method provides information on the entire process landscape the quantitative and qualitative effects of the introduction of a certain technology on an organisation can be assessed.

4 Evaluation of the PICTURE-Method

Two case studies have been performed in order to evaluate the PICTURE-method. The approach has practically been applied at the University of Münster as well as at the City of Münster.

University of Münster: The University of Münster is a public institution with about 40.000 students and an administration engaging 500 officials. In this case study 34 interviews with officials of the university's administration in six different departments were conducted. The project group was composed of a project manager; four sub-project managers and seven team members. Each interview was conducted by two team members together with one or two officials of the administration. In these sessions, altogether 168 processes could be identified and modelled. During the interviews, all processes were documented on paper. Process building blocks were applied to structure the discussion. After the interviews, the processes were translated into the PICTURE-language and sent back to the interview partners for review. If any corrections were made by the administration's officials the process models were adapted accordingly. It took 477 person hours to identify and document the processes, on average approximately three person hours per process. Only one person hour of these three hours was needed to model the processes. The rest of the time was used to prepare interviews, write a protocol and give feedback to the interviewers. Based on the experiences made a few missing process building blocks and a couple of attributes could be identified and were added to the language. Forty proposals for improvements could be derived from the PICTURE process models. With help of the PICURE tool the process models have been published on the intranet of the university.

City of Münster: The City of Münster has about 280.000 inhabitants and an administration with roughly 4.000 officials. Fifty-one interviews have been accomplished at seven different departments of the administration. A project manager, five sub-project managers and 14 team members were involved in this project. Based on the interviews 172 processes were identified and documented. These processes have been collected in two different ways, paper- and tool-based. Thirty-eight processes were acquired in the traditional form, first on paper and later modelled with the PICTURE-method. The remaining 134 processes were modelled directly during the interviews together with domain experts. For this purpose the web based PICTURE-tool was applied. As the process models were created within the interviews together with the administrative officials, a later review and rework was no

longer required. We experienced a much higher quality of the models with this second form of acquisition. Further inquires while modelling the processes in the tool as in the first option could be completely omitted. With the first version it took two-and-a-half person hours to acquire a process. More than one person hour was necessary to copy the processes from paper into the PICTURE modelling tool. Another 30 person minutes were required to prepare the interviews and to ask for feedback. With the second option a process could be finished in one-and-a-half person hours. Besides preparation most of this time was spend modelling the processes with the tool. Even though, it took somewhat longer than documenting on paper, the time for the transfer in the tool and later rework could be saved. Discussions with the administration's officials during the project showed that they appreciated the method as it is simple to understand and creates transparency in their processes.

Table 3. Process acquisition times

Project	Form of acquisition	Time to acquire a process
Regio@KomM	Paper based	6 person hours
University of Münster	Paper based	3 person hours
City of Münster	Paper based	2.5 person hours
City of Münster	Tool based	1.5 person hours

In comparison in the Regio@KomM project processes of a municipal administration have been acquired with the modelling language EPC [1]. The processes were comparable in structure and size with those at the University of Münster and City of Münster. In the Regio@KomM project the collection of 22 administrational processes took six person hours on average. The paper based modelling of a single process with the PICTURE-method required only half of that time. With the tool based modelling the time could be further reduced to a fourth. The participants at University of Münster and City of Münster who had pervious experiences with EPC modelling evaluated the PICTURE-approach as faster to learn and its models as easier to understand in comparison to EPC. Table 3 shows the different efforts per process and per project.

During the two projects the PICTURE-method was continuously evaluated and adapted if required. All inadequacies of the modelling method were documented [16]. During the project meetings obvious improvement possibilities were discussed and implemented throughout the course of the project. The reactions of the officials to the application of the method and all recognised advantages were noted. Also restrictions of the PICTURE-method were gathered in an evaluation document.

5 Conclusions and Further Research

Public administrations possess many properties that differentiate them from enterprises. A process modelling method must take these particular characteristics into account in order to be applied successfully. The objective of our research has been to develop a domain specific modelling method which meets the particular conditions of public administrations. Considering these specific features we have derived requirements in

order to allow for an efficient representation of the process landscape as well as the identification of reorganisation potential in public administrations. We developed the PICTURE-method to enable an economic modelling, analysis and presentation of administrational processes.

Comparing our results from the two case studies with the initial requirements we found that all of these conditions could be met by the PICTURE-method. The abstraction level of the process building blocks proved to be suitable. A better comprehensibility of the models compared with previously used generic modelling methods was explicitly emphasised by the involved officials (cf. requirement 1).Through modelling with the help of abstract process building blocks, structural variations could be observed less frequently compared to generic process modelling methods. This led to lower maintenance expenses, as rework efforts and the number of necessary changes on the models could be reduced (cf. requirement 2). Through the use of same process building blocks in different process models, the comparability of the models has been promoted. Furthermore, problems such as name or type conflicts within a model comparison have been reduced [24] (cf. requirement 3). Although, the focus of the two case studies primarily laid on the creation of transparency, some simple analyses based on the process models could be performed [25]. With the aid of building-block specific attributes, such as turn-around time, drop number or number of printed pages, these figures could be aggregated and calculated for each organisational level and unit (cf. requirement 4). Furthermore, the process building blocks of the PICTURE-method proved to be very easy to understand for the officials. We could show that the PICTURE-method shrinks the time to acquire a single process up to a fourth compared to the language EPC (cf. requirement 5).

An important conclusion of the two case studies is, however, that not every type of process can be modelled similarly well. Especially less structured processes and processes which are not based on documents were hard to grasp. Based on the results of the evaluation of the PICTURE-method the following objectives for further research can be defined:

1. *Complex analyses:* As described in section 3 the PICTURE-method provides mechanisms to measure the reorganisation potential of basic components. The current version of the method requires manual support to estimate the effect of certain software systems on the process landscape. This part of the method has to be improved in order to provide valid indices for basic components and to evaluate whether their introduction is economically reasonable. It is subject to further research to develop improved pattern-based heuristics for a fully automatic analysis of the collected processes.
2. *Stand-alone modelling:* In the project with the city of Münster 29 of the overall 134 tool based processes have been described without the support of a method expert. Two officials modelled their processes on their own and needed only about 30 minutes to represent a single process. The quality of these modelling results was notably high. This reveals a significant additional potential to further reduce the efforts of modelling the process landscape. However, the PICTURE-method and the tool must be improved in order to employ stand-alone modelling in an entire administration. This is subject to further research.

Acknowledgements. The work published in this paper is partly funded by the European Commission through the STREP PICTURE. It does not represent the view of European Commission or the PICTURE consortium, and the authors are solely responsible for the paper's content.

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