AGGREGATION OF REFERENCE PROCESS BUILDING BLOCKS TO IMPROVE MODELING IN PUBLIC ADMINISTRATIONS

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***Abstract**. Efficient methodological support of process modeling is an important prerequisite for the identification of modernization and automation potentials in public administrations. This paper analyzes the specific properties of processes in public administrations and discusses the potential benefits of reuse of process building blocks from a syntactic, semantic and pragmatic perspective.*

1 Introduction

In order to modernize public administrations, detailed knowledge about internal structures of organization and processes is an important requirement. However, in the public sector, there is only little adoption of documentation of these structures from an organizational, legal and technical point of view. A survey in 337 German speaking municipalities shows that in 77% of these municipalities no process modeling has been done in the past nor is scheduled for the future [1]. As principal reasons, the lack of knowledge and qualified employees as well as financial resources and appropriate modeling tools is stated. Taking these reasons into account, different fields of research can be identified in order to support modernization of the public sector. One important factor is to encourage the acceptance of process documentation by standardizing model-based formalization of processes. In order to simplify process modeling and to reuse existing process knowledge, other industries use the concept of reference modeling. After this introduction, Section 2 describes characteristics of service delivery in public administrations. Section 3 focuses on the aggregation of process building blocks, an approach of reference modeling to which only little consideration has been given in the past. In order to evaluate the applicability of this approach for usage in public sector, the quality of resulting reference models is discussed from a syntactic, semantic and pragmatic point of view [2]. Section 4 summarizes our findings and identifies fields of further research.

2 Characteristics of Service Delivery in Public Administrations

Since service delivery in public administrations differs in many respects from other industries, process modeling has to meet specific requirements. A considerable difference is the dependency of public services on governmental legitimacy. The legal assignment of service tasks results in a multitude and a variety of public "products". When comparing different institutions which are on the same administrational level, the list of covered services is quite similar. Regulating law and regional enactment often limit the flexibility of necessary changes. As a result, process redesign is mostly restricted to evolutionary improvements, continuous change management and a staged development of organization.

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Another characteristic is the output of public service delivery. In contrast to other industries, the results of typical decision-making processes within the public sector are in many cases not predictable. Complex administrational procedures can result in approvals or rejections as well as in interruptions or a forwarding of the whole case. In order to represent such flexibility, process modeling in the public sector needs appropriate constructs [3, page 133 et sqq.].

Having a closer look at particular processes, in conjunction with local regulations, individual scope of decision-making, and decentralized responsibilities similar services are produced by performing activities that are related within heterogeneous processes (cp. Fig. 1).

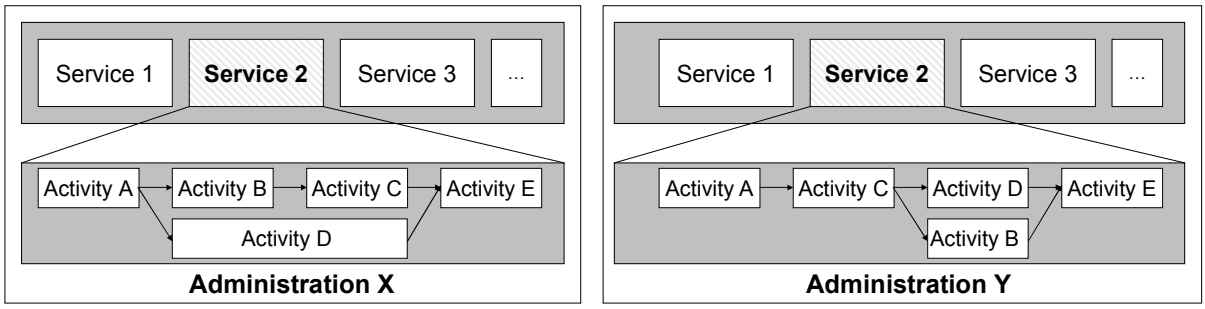


Fig. 1: Homogeneity (Services) vs. Heterogeneity (Sequence of Related Activities) of Public Service Delivery

According to Davenport and Short, a process is a sequence of logically related activities that is performed to produce a specified output (following [4, page 12]). For this article, we define a process activity as the execution of a particular task or function (model elements on a high level of detail). So called process fragments are a specific sequence of process activities forming a part of the whole process.

Analyzing the heterogeneous structures of public service delivery in more detail, process activities and even process fragments can be identified which are frequently reused within different processes (cp. Fig. 2). Consequently, the recurrence of such process components is rather high and smaller improvements concerning structural complexity, duration, quality or costs of these activities can significantly affect service delivery as a whole.

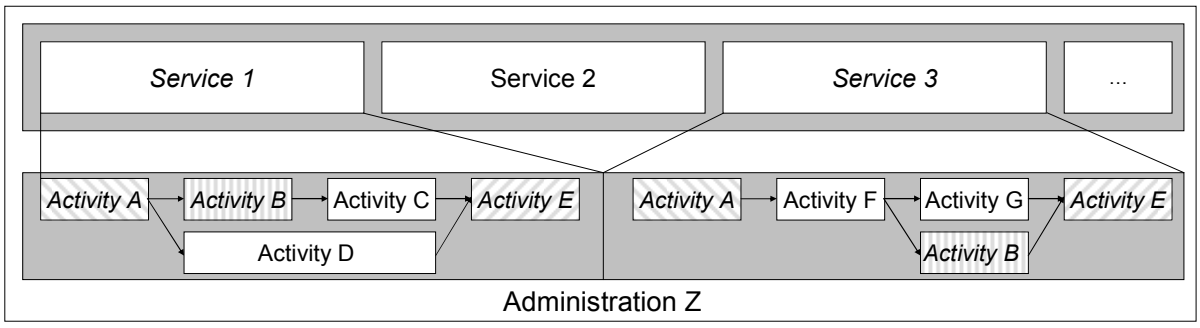


Fig. 2: Cross-process Reuse of Activities

Information processing of public administrations is characterized by document and case-based work as well as function-oriented organizational structures. The increasing specialization of organizational units (which focus on performing particular services or parts of services) leads to fragmented processes (cp. Fig. 3) that imply long transport times and idle periods. Cross-organizational, decentralized responsibilities implicate multilateral relations of communication and transaction, a high number of organizational interfaces and media breaks. The use of dedicated, specialized, non integrated information systems intensifies these effects.

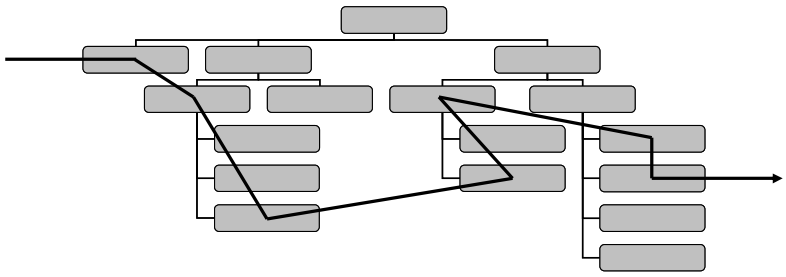


Fig. 3: Effect of Process Fragmentation Within Functional Structured Organizations

In order to adequately depict cross-organizational structures, the procedure of documenting, and analyzing processes is an important challenge. The various process owners need to be coordinated as well as their different perception of processes. Differences in terminology, a multitude of process modeling notations and tools as well as standardized and consistent levels of detail and abstraction (cp. [5, page 17]) complicate reorganization projects and increase project risk. The heterogeneity of used process documentation varies from complex formalized process models including different views (supported by integrated modeling tools), manually drawn workflows (supported by computer graphics or presentation software) to simple tables or textual descriptions [1]. In order to model cross-organizational processes within public modernization projects, it is important to enable decentralized generation of model parts and their integration into a holistic, integrated, and consistent process model. Problems often arise when employees are involved to gather information about "their" processes. Many process owners neither have sufficient knowledge about the concept of processes, nor are they familiar with process modeling. Furthermore, employees regularly are not able to commit sufficient time for modeling tasks in addition to their regular work.

Besides the heterogeneity resulting from usage of different tools and the related lack of syntactic consistency, there is vast heterogeneity in semantics of modeled process activities. In order to describe similar activities, individual modelers often use different names or refer to them by organizational units, events, and documents. Interpretation and analysis of such models cause extensive manual effort, e.g. to identify potentials for optimization. An automatic examination or implementation of such process models by means e.g. of electronic workflows is almost impossible. With regards to these challenges, the aggregation of semantically standardized activities (process building blocks) promises simplification as well as increased speed and quality of modeling.

3 Analysis of Process Building Blocks Aggregation

3.1 Classification of Aggregation

In order to enhance the effectiveness as well as the efficiency of modeling, generalized reference models are used as a starting point to develop individual models for a specific organizational or project context [6, page 17]. Their generality enables reuse of models or parts of models within one organization as well as the transfer of knowledge between different organizations. Another characteristic of reference models is its nature of recommendation (describing a desirable target state). In order to adopt a reference process model for a specific domain or context, different mechanisms can be used (cp. Tab. 1).

Configuration	Analogy-based Constr.	Specialization	Instantiation	Aggregation
… bases on a set of rules for the selection of relevant components from a general reference process model in order to create an individual model.	… reuses patterns of referenced model components (which are considered as similar) as parts of the resulting individual model.	… derives concrete components from generalized reference models.	... comprises placeholders which are filled with referenced model components or values selected from a defined range.	… describes the composition of general reference model components in order to create an individual model.

Tab. 1: Mechanisms to Adapt Reference Models (following [7, page 252])

Comparing these mechanisms, configuration is an often considered "top-down" approach (cp. Fig. 4). The contained rules depend on defined parameters [8, page 76 et sqq.] which need to be specified by users. Thus configuration transforms an entire reference model into an individual model with limited applicability. Therefore the mechanism requires extensive knowledge about all occurring elements as well as their ideal arrangement. In contrast the "bottom-up" aggregation of general elements (cp. Fig. 4) basically does not need regulating knowledge about the resulting process flow. However, limiting the variety of possible combinations of elements by a set of rules can simplify, support and control the modeling process. So plausibility checks become possible that increase the quality of resulting models.

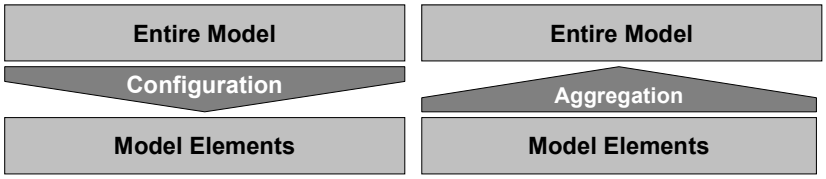


Fig. 4: "Top-Down" (Configuration) vs. "Bottom-Up" Approach (Aggregation)

As a consequence, aggregation seems to be well applicable to depict the characteristic of processes in public administrations. Especially the repetitive occurring activities can be adequately modeled by using standardized activities (cp. Fig. 2). Though contradicting the general recommendatory character of reference models, even suboptimal solutions can be created. This makes aggregation also applicable for description of a current situation and thus enables a continuous process improvement as required in administrations (cp. Section 2). Considering the characteristic of decentralized and function-oriented service delivery in the public sector, the reuse of repeatedly performed activities through aggregation claims to simplify, diffuse, improve and standardize modeling of administrational processes. Such components are designated Reference Process Building Blocks (RPBB) (cp. [9] / [5]). In order to be characterized in detail, these activities can be related to processed objects (cp. Fig. 5) or specialized by other attributes (e.g. duration).

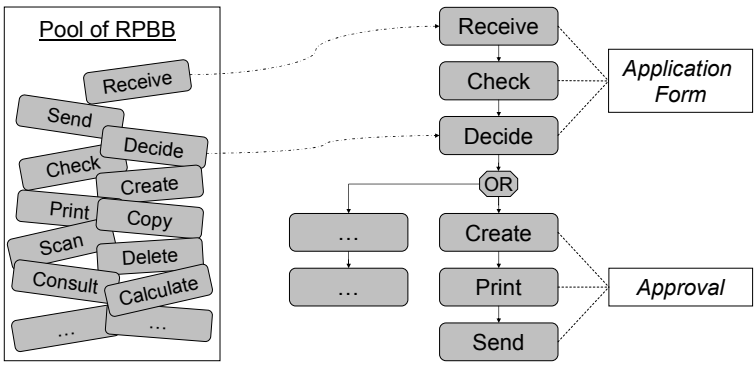


Fig. 5: Aggregation of Standardized Reference Process Building Blocks (Example)

In order to estimate the potentials of RPBB aggregation in the public sector, the model of Lindland et al. [2, page 44] is used.

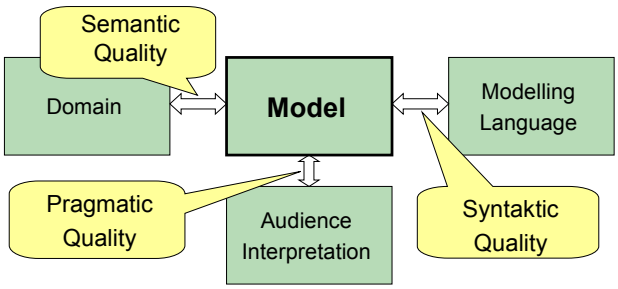


Fig. 6: Dimensions of Model Quality (following [2, page 44])

The authors derive the value of a model from its syntactic, semantic and pragmatic quality (cp. Fig. 6). Subsequent sections describe the identified potentials in detail.

3.2 Syntactic Quality

Syntactic quality of a model depends on the suitability of the used modeling notation without consideration of its meaning [2, page 44]. The notation contains elements and constructs (e.g. logical connectors and cardinalities) as well as rules for their combination. Different notations are used depending on the particular application context, the users and the specific goals of the analysis. While it is the main aim of RPBB to be defined as an interoperable data structure that abstracts from any particular notation (requirements of generality and reusability), Lindland et al. state that syntactic quality of a model mainly depends on its notation [2, page 44]. Following Lindland's argumentation the syntactic quality seems to be irrelevant for assessing notation independent RPBB. However, there are additional formal requirements for RPBB that can enhance syntactic quality of the used modeling notation. Such criteria of quality are plausibility checks and mechanisms to ensure consistency of models, e.g. by applying specific rules. These mechanisms need to be considered in all stages of the RPBB construction process. As an example, information objects (attributes) can be defined to express required information. Such attributes are specified by users for a situational context. This approach corresponds to the above mentioned mechanism of instantiation. Thus the mechanisms aggregation and instantiation can also be combined.

Processes of service delivery such as those in the public sector are usually characterized by decisions with individual latitudes, different results and branching (cp. Section 2). An example is the RPBB "Decide" which is followed by branching. A suitable notation has therefore to comprise specific constructs and logical connectors.

Regarding modeling notation, another quality criterion is the ability to enable depiction of cross-organizational service delivery processes of public administrations (cp. Section 2). As an example, so called "swim lanes" can represent organizational responsibilities and identify interfaces in a end user suitable form. For proper modeling, RPBB need to allow representation of such responsibilities and other additional information. Again attributes which depend on RPBB or a current context can be used. As a result, it can be concluded that RPBB structuring is an essential quality criterion from a syntactic view.

3.3 Semantic Quality

Semantic quality refers to the relation between a model and its meaning regarding a specified domain of application [2, page 44]. It extends the syntactic dimension by a content-based perspective. Semantics is an aspect which is insufficiently considered by existing process models. Although the notation of a model formally describes the meaning of its elements

(meta level), the precise meaning of instantiated elements is not defined in most cases. As an example, the meta level describes the semantics of a rectangle as "activity" (e.g. Business Process Modeling Notation, www.bpmi.org). However, the instantiated activities of the process model have to be manually specified by users. The precise semantic meaning of the activity depends on the individual decision and perception of a user. As a result, the analysis of models and their reuse is a mainly manual process. The approach of RPBB aggregation can realize essential potentials because the semantics of instantiated elements can be defined. As an example considering the meaning of a combination of elements, a process model can be transformed into an executable representation, e.g. to realize workflow functionalities within a workflow management system. Furthermore, the detailed knowledge about the relations of model statements enables an automatic analysis and optimization of the model. The identification of fault-prone or inefficient parts of a model, the comparison with available alternatives or even the generation of new process patterns allow the transformation of models which describe the current situation into models which describe a desirable target state. At the moment, such automatic reuse fails not only due to missing semantics, but also due to the enormous heterogeneity of process models (cp. Section 2). The standardization of abstraction levels [cp. "process compass" [5], page 15 et sqq.] as well as the definition of a common terminology allow the implementation of advanced plausibility and consistence checks that significantly exceed the capability of syntactic checks.

Furthermore, the definition of RPBB (referencing character) encourages comprehension of processes which is often missing in public administrations. The definition of adequate levels of abstraction and detail as well as a common terminology are an enabler for distributed modeling of particular process parts by process owners. Process parts can be assembled to one whole process model (cp. Section 3.2) as inconsistency on a semantic level will be prevented by use of standardized RPBB and rules for their combination. Concluding, from a semantic point of view RPBB aggregation provides the basis to adequately support specific requirements within public administrations such as the decentralized responsibilities, function-oriented specialization and increasing division of labor.

3.4 Pragmatic Quality

Pragmatic quality brings in the stakeholders of the modeling process by evaluating their correct interpretation of the model [2, page 44]. An essential quality improvement from a pragmatic perspective results from the modeling knowledge requirements for usage of RPBB. Many employees who are assigned to document their processes do not attend time and cost consuming courses. The mechanism of RPBB aggregation enables employees that are not experienced in process modeling (e.g. process owners) to efficiently create and maintain process models. Additionally, collaborative modeling of distributed decision processes encourages the management of heterogeneous process and IT landscapes.

The enhancement of pragmatic quality depends on the improvement of syntactic and semantic quality. A direct example is the "filling" of element instances with a meaning (cp. Section 3.3). This standardization of abstraction levels as well as the definition of a shared terminology helps to enhance process comprehension by stakeholders. Another example is the control of syntactic correctness, semantic consistency, and the check for plausibility (cp. Sections 3.2 and 3.3) by specific mechanisms. This enhances reusability and the pragmatic quality of process models.

A further advantage of quality from a pragmatic point of view is the flexibility of reference modeling. The mechanism of configuration is based on a complete model which is then

adapted by a parameter-driven (domain context) and user-oriented selection of model components, constructs or alternatives of illustration. This requires extensive knowledge about all elements and their relations (represented by complex parameterization) in the moment of reference model construction. The mechanism of aggregation covers a more flexible creation of individual (also suboptimal) models and moreover supplies the need for an efficient and a high quality depiction of process landscapes. As RPBB aggregation into a holistic model enhances comparability of processes in different organizations or organizational units, a prerequisite for an inter-organizational transfer of knowledge as well as the use of common and best practice models is provided. As there is no direct competitive situation in the public sector, the active presentation and easy transfer of created process models and standardized RPBB is another potential use case.

4 Conclusion and Outlook

This article discusses potentials of applying the aggregation of reference process building blocks in public administrations. Analyzing quality from a syntactic, semantic and pragmatic perspective, the benefit of this mechanism has been shown. RPBB aggregation conforms to the characteristic requirements of service delivery in the public sector and contributes to solve identified problems. Especially the parallel improvement of model quality in the three dimensions as defined by Lindland et al. has the potential to promote acceptance and to support diffusion of reference modeling techniques, thereby enhancing the goal-oriented modernization of public administrations. RPBB aggregation also supports generality and reusability. Its recommendatory nature is present because RPBB provide a standardized basis for process modeling. Additionally the definition of related rules excludes incorrect combinations of RPBB and therefore ensures the recommendatory character of resulting models. However, resulting models need not stringently represent a desirable target state. The creation of suboptimal process models facilitates continuous process improvement (cp. Section 2). Identifying inefficient process components and proposing optimized combinations of RPBB, the aggregation of standardized RPBB prospectively enables the transformation of models which describe the current situation into models of a desirable target state. However, evaluation of the presented approach will be elaborated by ongoing research especially considering practical relevance.

Based on the findings of this paper, detailed requirements for the RPBB construction process as well as the structuring of RPBB need to be identified that conform with the above mentioned quality criteria. In order to describe RPBB in more detail (e.g. by defining appropriate attributes), the mechanism of instantiation has to be considered as well (cp. Section 3.2). Following Malone et al. [5], RPBB can be initially generalized and successively specialized during the adaptation process of the reference model increasing the importance of mechanism of specialization. In order to realize the aggregation approach, the development of specific rules is closely related to the RPBB construction process (cp. Sections 3.2 and 3.3). This is another important field of future research. From a pragmatic perspective, RPBB can be used to identify services on a functional level. These functional services are a basis to develop technical services and to design service oriented architectures and workflows. So the function-oriented organization of public administrations proves to be beneficial as service orientation provides means to improve fragmented and cross-organizational service delivery processes (cp. Fig. 3).

When defining RPBB, the identification of adequate levels of abstraction and detail (cp. [5, page 17]) is an important task. A higher level of detail of RPBB requires a higher effort for

gathering necessary process information. This can be countered by defining typical RPBB patterns (reusable process fragments). In order to identify such Reference Process Fragments (RPF), techniques of analogy-based construction can be used. RPF can also be aggregated into holistic models and are therefore expected to simplify and speed up process modeling. Resulting process models become more comprehensible because of the lower level of detail.

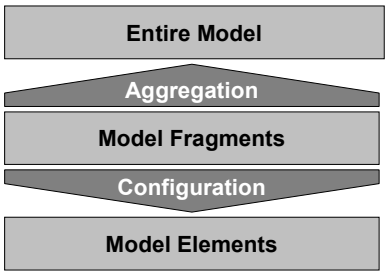


Fig. 7: "Out-of-the-Middle" Approach – Configuration and Aggregation of RPF

Compared with holistic reference models, RPF are less comprehensive and easier to adapt by using configurative mechanisms. So the complementary use of configuration and aggregation ("out-of-the-middle" approach) promises significant improvement of modeling processes (cp. Fig. 7). In addition to configuration, the above mentioned mechanisms of analogy-based construction as well as specialization and instantiation can be applied to supplement specific aspects of the RPBB / RPF aggregation. Future research activities are necessary to analyze the combination of adaptation mechanisms within the context of public administrations.

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