Jörg Becker, Irina Thome, Burkhard Weiß, Axel Winkelmann

Constructing a Semantic Business Process Modelling Language for the Banking Sector

An Evolutionary Dyadic Design Science Approach

The need to extensively model business processes for multiple purposes (e.g., documentation, compliance management, analysis and optimisation etc.) is of major relevance to banks. Efficiently modelling and automatically analysing business process models not only in a syntactical but also in a semantic way becomes increasingly important in order to save costs during process model construction and achieve additional value from process modelling initiatives. In this article, we introduce a domain-specific semantic business process modelling language (BPML), which supports efficient modelling and semantic analysis needs of banks. We do this by adapting an existing domain-specific BPML from the public sector and applying an evolutionary design science research approach that covers several design science cycle iterations. We triangulate and evaluate the final design science artefact (a new semantic BPML for banks) with the help of a multi-method approach using interviews, round table discussions, document analysis, literature analysis and two in-depth case studies from a specialised bank and a universal bank in the financial sector.

1 The Need for Process Modelling in the Banking Sector

During the past decades, business process modelling has become an important mean in business reorganisation and management projects. A business 'process is a completely closed, timely and logical sequence of activities which are required to work on a process-oriented business object' (Becker and Kahn 2003, p. 4). Modelling is a way to capture the implicit process knowledge and hence the dynamic perspective of an organisation and document it explicitly in a (semi-) formal way. It describes the logical sequence of activities, the resulting products and services, the required resources and data, as well as the involved organisational units (Lindsay et al. 2003, p. 1015). These process models can be used e.g., as a basis for decisions on IT investments, reorganisations or the selection and implementation of information systems. Furthermore, a semantic analysis of the model inherent knowledge can explicate the underlying corporate structures and procedures.

According to (Hung 2006, p. 37), business process management (BPM) as a field of study is still in its infancy, although there is a vast amount of studies for its usage in various sectors and industries. An effect of the popularity of process orientation that can be noted in organisational practice is that much effort is being spent on the creation of business process models for the documentation and analysis of business processes (Mendling et al. 2009, p. 2). For example, more than 70% of the German banks intended to apply process modelling and reorganisation in 2007 (Spath et al. 2007).

In a recent study among process modelling experts in banks, Becker et al. (2010d) see much potential in improving the effort-utility-ratio of process modelling in the finance sector. They found evidence that the existing methods to support business process modelling and analysis initiatives in banks may not be ideal. This finding is supported by the fact that nearly one third (19 banks) of the responding banks had to adapt standard business process modelling languages to their individual needs. Especially with a semi-formal specification of business process models (e.g., with the help of the event-driven process chains (EPC)) the automated consolidation of models from different modellers as well as the model analysis is hardly possible. Nevertheless, an easier design and the automated semantic analysis of business process models would allow significant cost saving potentials in contrary to manual evaluations. Current broadly distributed, commercial modelling tools provide only limited support for the automation of analyses (Blechar 2007; Aalst et al. 2003, p. 9). In many cases, highly trained advisers with sufficient domain expertise are necessary to evaluate the inherent syntax and semantic of models Vergidis et al. (2008a, p. 69). Asked by Becker et al. (2010d), nearly one third of banks with standard business process modelling notation in use were willing to support the development of a modelling language that better suits the needs of banks and allows for automated analysis of processes, and one half of all banks is looking for better process modelling and analysis methods. Hence, in this article, we propose an easy to use semantic modelling language for the banking sector that allows an automated semantic process evaluation. Using a design science approach we adopt the recommendations for design science procedures from Peffers et al. (2008) and Hevner et al. (2004). We introduce research results from the adaptation and application of a semantic business process modelling language (BPML) to the banking sector in order to achieve easier modelling coupled with an automated analysis of the resulting process models.

2 Shortfalls of Current Process Modelling Languages and Research Approach

The need to extensively analyse business processes for multiple purposes is currently of major relevance in the banking sector (Becker et al. 2010d; Cocheo and Harris 2007, p. 3; Papastathopoulou et al. 2001, p. 149; Spath et al. 2007; IBM 2005) and has become even more important due to the financial crisis. Analysis purposes in banks include the optimisation of business processes, compliance of processes with legal rules, management of (operative) risks in the process landscape, human resource requirements planning according to necessary capacities and skills for executing processes and product costing according to the process-oriented allocation of costs (Becker et al. 2009, 2010c).

Despite the promising potentials of business process orientation, various deficits in business process management and modelling can be detected in generally applicable modelling languages (IDS Scheer 2007; Vergidis et al. 2008b, p. 91). For example, many researchers such as Lin (2008); Thom (2006) address the lack of appropriate modelling techniques that are easy to comprehend and efficient for process optimisation. However, according to Recker et al. (2009, p. 355) 'current process modelling techniques only capture the reactive, intrinsic part of process flexibility, but lack contextualisation.'

Nevertheless, there are various research projects and prototypes, which deal with pattern design, identification and contextual annotations and analyses of process models (Celino et al. 2007). For instance, Thom (2006) identifies typical block activity patterns as business functions frequently found in business processes. Iochpe et al. (2007) discuss a suite for business processes based on the reuse of context-sensitive workflow patterns. Often, process modelling languages are linked to ontologies. For example, Lin (2008) introduces an ontology-based semantic annotation approach to enrich and reconcile semantics of process models. Thomas and Fellmann (2007) also use metadata to connect actual process models to ontologies. Those approaches require a domain ontology and a (manual) matching between business process models and ontological concepts. In our point of view, this two-step approach is very difficult to communicate and use in practice, especially when it comes to large modelling and analysis projects. In addition, within our projects and expert interviews in the banking sector, we repeatedly realised that modellers only used generally applicable modelling languages without any specific relation to the banking sector (Becker et al. 2010d). Furthermore, it turned out that these languages did not support an economically efficient semantic analysis of business processes required by banks. Thus our objective was the development of a semantic BPML for the specific application of IT-driven business process analysis in the banking sector. It should allow for an efficient modelling of business processes not only by modelling experts but also by business professionals, a comparison of business process elements or subprocesses as to whether they are semantically equal, similar or different (although they might be named differently) for benchmarking purposes, and a pattern search for models in order to automatically identify weaknesses in process models detected through the occurrence of a particular set of model elements (e.g., the number of media breaks or organisational unit changes).

As a consequence of the identified shortfalls, we wanted to engineer a method that allows for an automated analysis of process models in the banking sector. Within method engineering, it is possible to distinguish approaches by their starting point. Ralyté et al. (2004, p. 204) describe four different approaches in order to create a new modelling language. The ad-hoc strategy is concerned with the construction of a novel me-thod from scratch. It is necessary if no other modelling languages seem to be feasible. The paradigm-based strategy (Ralyté et al. 2003) starts from an existing meta-model of a modelling language in order to derive a new method. In contrary, the assembly-based strategy reuses method fragments to construct a new method (Gupta and Prakash 2001, p. 154). In addition, the extension-based strategy focuses on an existing method and provides new additions to it.

Many 'new' modelling languages originate from other languages and hence are adaptations or extensions of existing languages. We therefore decided to start our research with a closer look at existing domain-oriented languages, which allow for an automated semantic analysis of process models. As a result of our first literature review and in accordance with the related work already identified in this area, we decided to adapt the PICTURE language to the requirements of the banking sector.

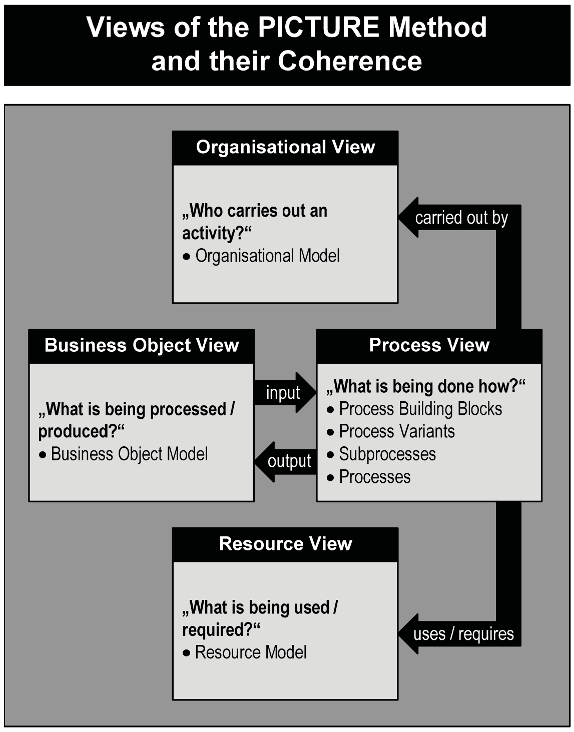

Figure 1: Views of the PICTURE Method

Within the process of searching for suitable domain-oriented and analysable semantic BPMLs, we soon realised that there is a lack of practically applicable domain-specific languages for banks (Blechar 2007). Comparing similar domains to banks (i.e., public administrations and insurance companies) we found the PICTURE modelling language to be suitable for our needs. It originates in the public administration sector and supports the semantic analysis of process models (Becker et al. 2006, 2007). Originally, the PICTURE approach is a result from multiple research projects in public administrations (Becker et al. 2006). It strives for a flexible, efficient and simple representation of administrative processes. The

PICTURE modelling language consists of four views, comprising a process view ('how is a service delivered?'), a business object view ('what is processed or produced?'), an organisational view ('who is involved in the modelling process?') and a resource view ('what resources are used?') (cf. Figure 1).

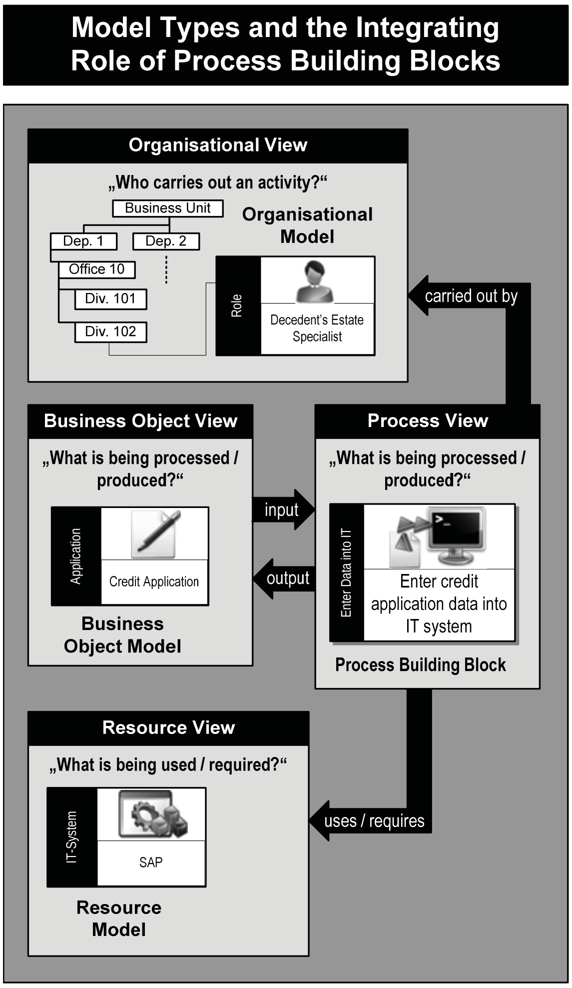

Figure 2: Integrating Role of Process Building Blocks

The core constructs of the PICTURE language are 24 domain-specific process building blocks (PBB), which have an integrating role by connecting all views (cf. Figure 2). A PBB represents a certain set of activities within an administrative process and applies a domain-specific vocabulary. PBBs are atomic, have a well-defined level of abstraction and are semantically specified by a domain concept. With PBBs problems like naming conflicts in a model comparison are avoided, because the name of a PBB is specified by the language designer rather than the modeller (Pfeiffer 2008, pp. 111-113). Examples for PBBs are 'Document / Information Comes In', 'Perform Formal Verification', 'Enter Data into IT', or 'Archive Document'.

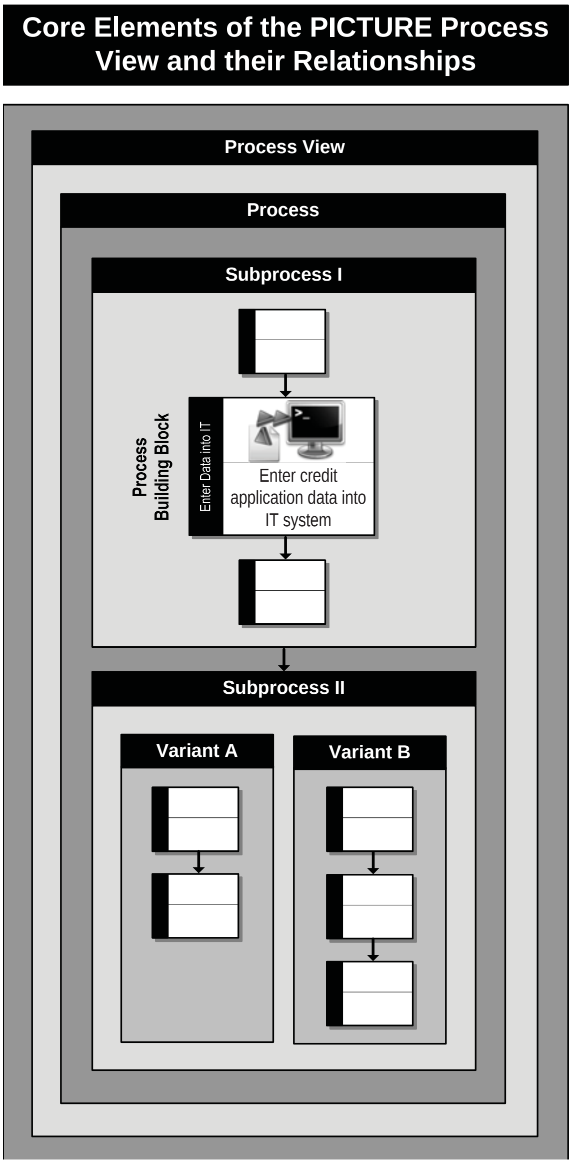

Figure 3: Elements of the PICTURE Process View

PBBs belong to the process view and represent the lowest abstraction level of a process model. They are contained within different variants of subprocesses. The subprocesses, representing the activities of just one organisational unit, are in turn part of a larger process, which usually involves multiple organisational units and thus multiple subprocesses (cf. Figure 3 for all language constructs).

Additional facts about the processes can be collected with the help of attributes assigned to each block. These attributes specify the properties of the corresponding PBBs in detail. For example, a possible attribute for the PBB 'Enter Data into IT' is 'Duration'. Attributes provide the core information for a subsequent process analysis. They establish a connection to the business object, organisation, and resource view.

In the PICTURE notation, processes are represented as a sequential flow of PBB (cf. Figure 3). This sequential order restricts the degrees of freedom of the modeller and simultaneously promotes the construction of structurally comparable process models as they are linear on a subprocess or variant level. However, on the downside, this strict sequence approach does not allow for intersections. As a solution, PICTURE allows either the modelling of process variants that define an alternative sequence within a subprocess or the annotation of special attributes. The latter can be used to hide simple cases of process complexity by avoiding additional variants (e.g., for alternate communication channels through which a document enters the organisation) or by specifying optional PBBs in a sequence with percentage values, regarding their actual occurrence in subprocesses. Furthermore, an anchor allows for establishing connections between PBBs in different subprocesses and variants to enable parallel process structures.

With regard to the processes, for which the domain-specific PICTURE language was designed, we expected banks to be more similar to public administrations than to, e.g., retail or industry companies, so that a transferability of the general methodology seemed feasible. For example, most processes in banks are also of an administrative nature, highly repetitive and described in a linear way. In many cases, the processes are also highly structured, consistent and standardised due to legal obligations. As a result of these similarities, we decided to apply an extension-based strategy in order to develop a domain-specific semantic building block-based language.

For the development of a semantic process modelling language for banks we applied a problem-centred approach according to the design science research methodology (DSRM) presented by Peffers et al. (2008), while aligning our research with the seven guidelines for design science research by Hevner et al. (2004). We selected a design science approach for our research methodology since it addresses important unsolved problems in a unique or innovative way or solved problems in a more effective way. On one hand, we were faced with the solved (more general) problem of business process modelling and analysis and provide a solution to handle this more efficiently (i.e., less human resource consuming). We do this by creating an innovative artefact, whose former absence led to highly resource consuming modelling efforts and laborious manual analysis of business process landscapes. On the other hand, we can argue that we also faced the unsolved (more specific) problem of automatic business processes analysis in the banking sector, for which we provide a basis with our new artefact.

The DSRM approach consists of six main activities (cf. black boxes on the left side of Figure 4), which we each present in detail in a separate chapter of this paper. From a top level methodological perspective we utilise different research techniques (e.g., interviews, case studies etc.) in each activity to appropriately support our overall objective. The activities we follow in this paper, after identifying the actual problem and our objective of developing a semantic BPML for banks, are described within our general research approach (cf. Figure 4).

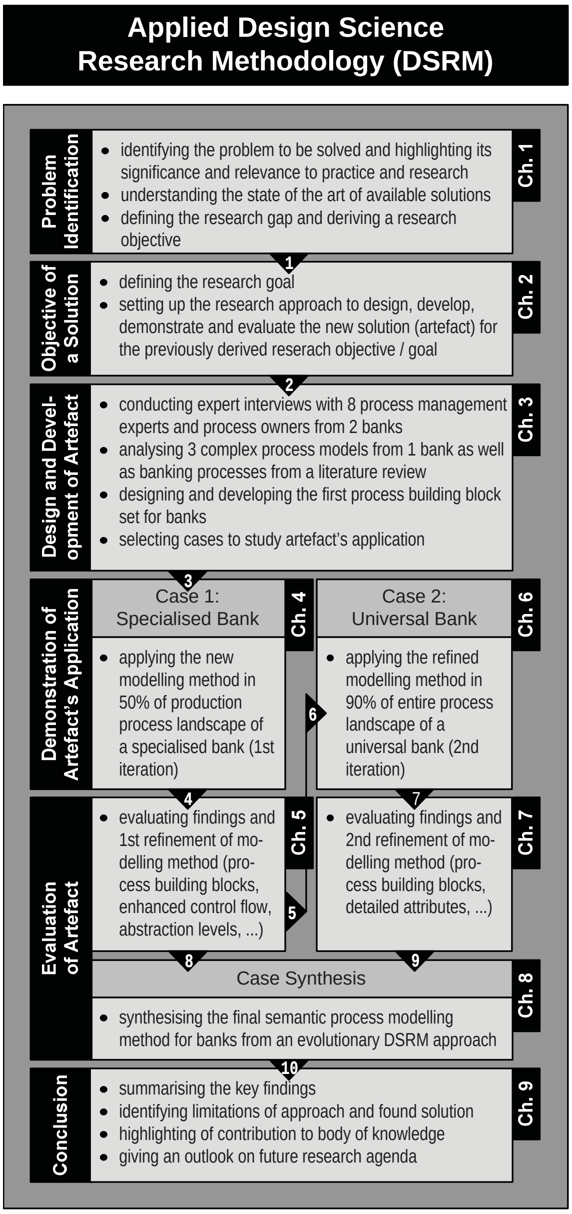

Figure 4: Research Approach and Framework

Design and Development: We cooperated with a large globally positioned universal retail bank and a specialised bank, focusing on consumer credits only, to find out about their specific needs for process modelling and analysis. In particular, we made interviews and asked process management experts from these banks what needs to be changed in existing process languages, and if and how the PICTURE approach may also be suitable for the banking sector. This was accompanied by a further literature review on typical banking processes and activities. To adapt the language and design our initial artefact we conducted an in-depth analysis of an extract of one bank's process landscape. We then defined different criteria for selecting appropriate cases to study our artefact and evaluate its application. As a result we selected the specialised bank we had started working with during our interviews, as it covered the most typical process of banks (the credit process), and we started a cooperation with a third bank – a universal bank with a completely different setting according to our criteria to be able to argue a generalisability of our artefact later on. Analysing all different possible banks or even just bank types and their process landscapes to provide a complete artefact seemed infeasible. Simon (1996) suggests in such cases to narrow the search process to find a satisfactory solution, i.e., satisfying solution without explicitly specifying all possible solutions. By cooperating with three banks, we have thus followed the research approach from Simon (1996) to find a valid artefact, which may not be the final solution, but close to optimal and thus applicable to most banks.

Demonstration: Therefore we conducted two in-depth case studies, in which we applied our new semantic BPML to two very different types of banks. For example the partner banks differed with regard to the legal system they operated in, their bank type and offered product spectrum, and their value chain architecture. Furthermore, the process modelling approaches established in both banks differed with regard to the goal of the modelling initiative, the scope of the process documentation, as well as the process modelling language and thus process abstraction levels each of them currently used. The cases are described in detail in Sections 6 and 8.

Evaluation and Conclusion: To evaluate the adapted PICTURE modelling language for the banking sector, we used three techniques common to evaluation in design science research (Hevner et al. 2004): we used informal argumentation to build a convincing argument for our artefact's utility regarding efficient process modelling and analysis capabilities by building upon the previous research results from PICTURE publications and transferring findings from the similar domain of public administrations, where these were arguably also applicable to the banking sector. In addition, we used the scenario technique when we constructed detailed scenarios for process analysis (i.e., process optimisation as a specific purpose scenario for process analysis as opposed to process analysis for ERP system implementation and process monitoring) around our developed artefact to demonstrate its utility. And we followed Peffers et al. (2008), who suggest to compare the artefact's functionality with the solution's objectives, as well as to use client feedback and logical proof. These research techniques revealed that the artefact was good for the given problem in the given context as after two iterations of designing the language there was nearly no further need to extend the semantic BPML (even the PBBs converged to a stable set) to be able to model and analyse the processes of the participating banks. Finally, even though analysability was 'given upfront' through the adaptation of an approach designed to fit the needs of analysability, we also verified and proved this in our case studies by detecting several typical process weakness patterns. Finally, we critically discussed the limitations and constraints of our new artefact and concluded with an outlook.

3 Designing and Developing a First Business Process Modelling Language Artefact for Banks

Confronted with the goal to construct a semantic BPML for banks, we chose to do use a multi-method triangulational approach to design and develop our initial artefact (cf. Figure 5). This was done by first assessing the feasibility of transferring the PICTURE language to banks, and then by drafting the artefact to be developed according to findings from a first small case study and a further literature review.

Regarding feasibility we chose two banks. We chose a specialised bank, focusing only on instalment credits (one single product) and delivering this to over 900 partner banks focusing solely on sales for these types of consumer credits. The bank was operating in Germany and Austria with 60 subsidiary credit shops in different cities. It employed over 1,000 people in 2008, who altogether as a bank served 443,000 customers, totalling a credit volume of 4.9 billion euros. As the credit process is the most studied process in literature and this bank was only focusing on it, this bank seemed to be a well-suited starting point for us.

Complementing this specialised bank, we chose a universal bank, which was globally operating in all major and typical product fields of banks and its German subsidiary, with which we cooperated, esp. focused on consumer credits, investment counselling, credit cards, and giro accounts in Germany. It was serving over 3.4 million customers with 6,600 employees in over 335 branch offices, with a balance sheet total of 12.8 billion euros in 2008. After several interviews and round table discussions with eight process management officials, internal auditing and compliance managers as well as process owners from specialists departments of the two banks we received first positive feedback that a successful adaptation of the PICTURE language according to our identified research gap and purposes seemed feasible and promising to these banks.

Based on this positive result the specialised bank agreed to give us an insight into an extract of their core business processes to adapt the PICTURE language and design our initial artefact. We asked the bank's BPM experts to select a representative set of process models, which would cover a broad range of typical processes and activities in banks. Thus, we received 3 complex end-to-end process models from the bank's production processes (covering all subprocesses

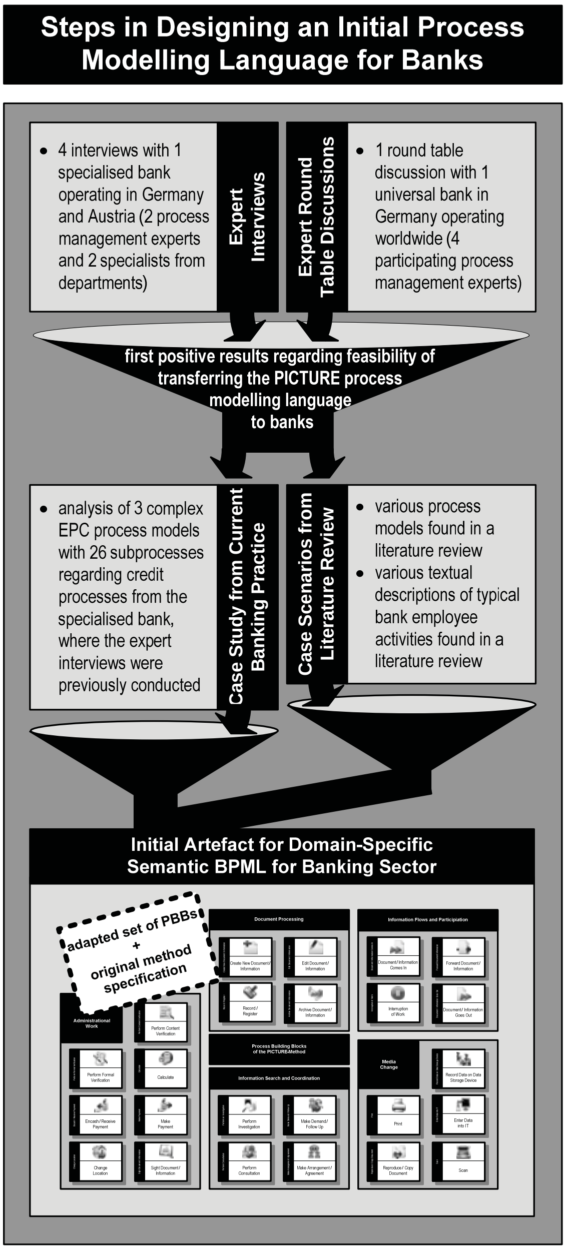

Figure 5: Domain-Driven Design Process

from a client's first approach to the bank until the service / banking product was fully delivered by the bank to the customer) in the EPC notation.

In addition, we identified and analysed further documented banking processes and typical activities in banks from a further literature review. Assuming that only the PICTURE PBBs needed to be transferred to the banking sector, we extended the PBB set (cf. Table 1). In this process we used a consensus-building approach among all modellers and analysers, to select and define the minimal amount of PBBs (and semantic vocabulary), necessary to describe and analyse all activities in the given processes without losing information from the previous process models when modelling and analysing these in PICTURE. The core result was an initial semantic BPML (SBPML) artefact with adapted PBBs, referred to as the SBPML for banks notation.

To demonstrate the applicability of our artefact we chose two bank cases (cf. Figure 6) according to our initially described criteria in our research approach. The first bank was the same specialised bank (referred to as case 1), which we had previously used to design the initial semantic BPML. This was due to the fact that we wanted to evaluate if our artefact was at least also valid for a larger part of the bank's processes, from which our initial adaptation had resulted.

For our second case we did not use our initial second bank partner (the universal bank) since it was similar to case 1 regarding the environment criterion and also active on a nationwide basis. Instead, we strived for another third case that was different regarding all of our previously defined case selection criteria. We found a partner bank in Russia (and thus in a totally different legal setting) that was also a universal bank (now referred to as our new case 2), but with a regional focus. In addition, it followed an integrator approach (Heuskel 1999), since it completely covered all value chain activities by itself in contrast to our first bank case, which served as a layer player (Heuskel 1999). Also our new second case bank had just a simple textual process documentation supplemented by further function models of core activities.

From our point of view these two cases perfectly complemented each other, thus providing a sound basis for further demonstration and evaluation of our artefact. At the same the cases

Criteria-Based Approach to Selection of Bank Cases to Study

	Case 1	Case 2
Type of Environment	developed country (Germany)	newly industrialised country (Russia)
Type of Bank	specialised bank (offering only one single product)	universal bank (offering multiple products)
Type of Value Chain Architecture	nationwide activities delivered and operated for 900 other banks as a layer player	regional activities delivered and operated through bank branch offices as an integrator
Process Modelling Goal	identifying process optimisation potentials and implementing a software for realtime production process monitoring and steering	documenting the process landscape as a business blueprint for analysing processes in an ERP system (SAP) with the SAP Solution Manager
Process Modelling Scope	50% of production department processes covering everyday core bank activities	90% of entire process landscape covering most departments of banks head office
Process Modelling Language	event driven process chain (EPC) with additional elements	textual process descriptions and integration definition for function modelling (IDEF0)

Figure 6: Selection of Bank Cases Method Adaptation

provide the opportunity to generalise findings, given that they were chosen to provide a maximum difference on key BPM aspects.

4 Demonstration Case 1: Specialised Commercial Bank

In our first case study we were given complete access to more than 50% of the bank's main process landscape regarding its production activities with the goal of optimising business processes.

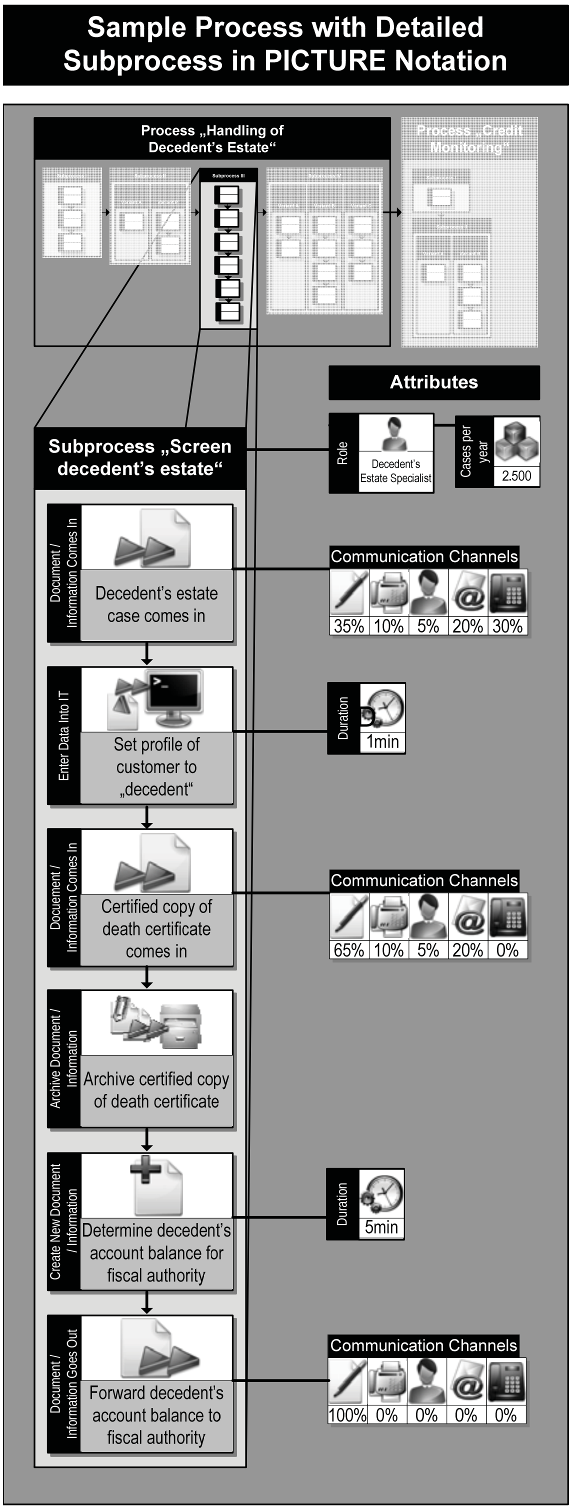

Figure 7: Selection of Bank Cases Method Adaptation

Originally, the bank had four departments (i.e., product engineering, portfolio management—managing the bank's risks, sales—focussing on client counselling, and production). Since product engineering, portfolio management and sales did not have highly standardised or even structured processes, we concentrated on the production processes. The production department processes were mostly administrative, highly repetitive and structured processes and seemed appropriate for extensive process modelling and analysis and also predestined according to the focus of the original PICTURE approach, as it focused on these types of processes. Processes analysed in the production department included the production unit, the service and support centre unit, as well as the shared services unit.

Applying the adapted PICTURE language in this setting, we were able to model all activities and processes without the necessity of further extensions of the PBBs (cf. Table 2 vs. Table 1). An extract of our modelling effort can be seen in Figure 7. Nevertheless, we had to make some adaptations to the overall process view of the original PICTURE language, described in our evaluation phase.

5 Evaluation of Case 1: Specialised Commercial Bank

During the course of the first demonstration project, covering a large share of the core daily business processes of the specialised bank, we modelled and analysed 34 banking processes with 84 subprocesses, 258 process variants and 693 activities in the form of PBBs with a team of 13 modellers. We conducted intensive interviews of more than 500 hours interview time with employees from the different departments of the bank that were involved with the execution of the analysed business processes before, during, and after the language development and modelling. These interviews were done to identify different activities and abstract from these to common activity types in banking processes, which resembled the PBBs from our first small case study at this bank. It turned out that the extensions we had done in our first small case study were also supported by our extended case study at this bank and no further extensions of the PBB set were necessary. However, we were able to reduce the PBB set as a result of our modelling experience at this bank so that we were able to combine six PBBs to three PBBs, while hiding the marginal differences between the original six PBBs in attributes of the three resulting PBBs and thus making modelling easier, as no more inconsistencies could occur due to a misinterpretation of just slightly different PBBs.

Compared to the original PBBs known from the public sector, this case overall resulted in six new PBBs (cf. Table 1) and three more general PBBs (cf. Table 2). Concerning the processes in the bank, we were confronted with many payment activities, as well as many verification activities and documentation activities, but also many accounting activities, which were performed by employees. As the old PBB had two different PBBs for incoming payments and outgoing payments, we merged these two closely related PBBs to one PBB named 'Make / Receive Payment'. We were able to differentiate incoming and outgoing payments by the introduction of a new payment PBB specific attribute, which could differentiate between an ingoing or outgoing payment. A similar optimisation possibility for reducing the complexity of the PBB set was given as the old PBB set had two PBBs for verification activities (one for formal verification – i.e., missing fields in a document and one for verification of content – i.e., verification if claims made via an application form could be accommodated by the bank or not). Since these two PBBs are again closely related, and there was no necessity to strictly separate these activities, we also merged these two PBBs to form a more general PBB with the new name 'Verify Document / Information'. Another merge was done regarding 'Make Arrangement / Agreement' and 'Perform Consultation', as making an arrangement or agreement always occurred after a consultation, but a consultation was not always succeeded by an agreement (only a successful consultation). Thus we merged these two PBBs and introduced a new attribute for the resulting PBB, which differentiated if an agreement would follow or would not follow.

We had to add the PBB 'Request Document / Information' as it was semantically different from the PBB 'Make Demand / Follow Up' in the communication channel it used (written form vs. direct contact via phone or in person). Regarding documentation activities, we had to create a new PBB since there was no adequate PBB to describe this activity and this was an activity which was frequently found in the banking processes and thus justified the action of creating a new PBB for the act of documenting something (the PBB was named 'Record / Document'). As accounting transactions were made almost as frequently as documentation activities and are daily business in banks, we used this to justify the creation of another new PBB named 'Make Accounting Transaction'. One other activity, which was performed sometimes and did not correspond to any existing PBB, but complemented the existing PBB set well, was 'Destroy Document / Information', which was integrated into the PBB subset 'Document Processing'. As typical management activities like planning, monitoring or steering were also of interest to the bank's process documentation we had to further expand the PBB set to include a high level PBB under which all three activities could be subsumed. This new PBB was called 'Management Activity' with an attribute refinement for differentiating what type of management activity was performed. With this last new PBB we were also able to document and analyse management processes, which were formerly not part of the specification PICTURE was designed to. Originally it was only designed to support the modelling of core administrative or operational and support processes but not management processes.

A first real peculiarity of the banking process activities we analysed was that the bank tried to not only model human activities but to a certain extent also modelled IT system activities since banks nowadays are highly IT-supported and many activities are hidden and performed solely by the IT. To not lose this knowledge the bank required to be able to model these types of activities. The difficulty was to decide how to integrate this request into the PICTURE approach, as it was originally only designed to support the modelling of human performed activities. Option a) was to define the IT system as an 'organisational role' and to link the IT system role to the PBBs provided also for human activities. Option b) was to extend the existing PBB set to include various IT system activities and option c) was to create one new PBB, which would hide the complexity of IT system activities, but would yet preserve the knowledge of which processes were triggered and automatically processed by the IT system landscape. We decided against option a) as sequential subprocesses in the PICTURE notation follow the 'model what you do' principle and thus an employee should be able to model his own activities without knowing what the IT system does in the background. We decided against option b) as adding too many new PBBs would make the PBB set too complex to use for modelling purposes. We wanted to keep the set well-arranged and small for the reason of ease of use. Therefore we decided for option c) and created one new PBB named 'System Activity', which would belong to the subset 'Information Flows and Participation'. Thus, an employee would simply model this abstract non-human activity into his process without having to know what would happen behind it, and the IT department experts could use more sophisticated models from the UML standard, for example, for defining IT processes and data flows on a lower granularity level, which is typically needed for IT implementations.

A second peculiarity was that, in opposition to our experience from the public administration sector, customer activities were included in process models because banks are very customer-oriented and also try to optimise customer activities. Since PICTURE was defined to support only company-internal business processes, we solved this hurdle by introducing a new organisational role for customers aside from the normal internal organisational chart, which is used in the organisational view of the PICTURE methodology.

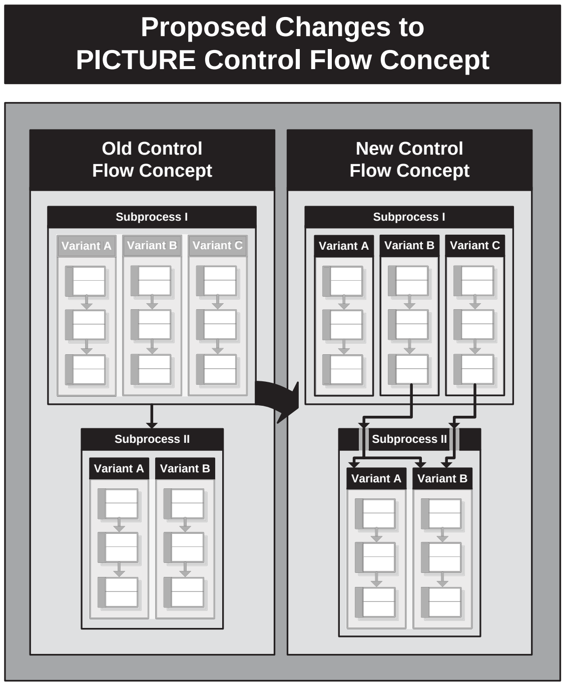

Figure 8: Control Flow Concept

Finally, our 25 interviews with bank employees from the specialist departments and interviews with 7 business process management experts from the BPM, auditing and organisational development departments revealed that two further activities were very common and needed to be documented within the business process models. These were creating follow-up activities (i.e., when an employee sent a document to a customer and needed a response within a specific time frame) and the application of the four-eyes principle in numerous activities. As these tasks are not very complex, but moreover usually supplement other activities, we decided to integrate these facts into PBB specific attributes, esp. those including document flows and client contact regarding the setting of follow-up requests, and those where payments and transactions were made with respect to the four-eyes principle.

On a higher granularity level above the PBB level we were also forced to adapt the PICTURE approach, since banking processes were found to be very complex and the bank we studied had additional requirements rarely found in public administrations. For example there was a need to be able to fully track the control flow in process models due to auditing requirements to check for legal compliance. In the original PICTURE language it was not possible to connect different variants from different subprocesses with each other. A restriction in the form that variant A and variant B of subprocess II only followed after variant A from subprocess I thus could not be depicted (cf. Figure 8). It was only possible to connect a complete subprocess with another complete subprocess and then differentiate in how many cases a variant of the following subprocess was actually carried out. We resolved this issue by changing the previous control flow paradigm, so that modeller A, owning subprocess A, could establish an outgoing control flow from each variant of his owned subprocess to a succeeding subprocess. The following subprocess, owned by modeller B, could then use these multiple incoming control flows and connect it to individual variants of the following subprocess, while using percentage values to specify the likelihood of each variant's occurrence after a previous subprocess (cf. Figure 8).

Furthermore, the bank demanded to have a visual aid on a high abstraction level, which was not formerly part of the PICTURE methodology. Originally the method just focused on visualising the PBB sequence in a variant and just mapped these variants to subprocesses and on the topmost level to processes. Thus, we had to introduce a value chain level (process map) above the process level, which would serve as a framework to group processes (e.g., according to similar tasks or products) and which could visualise the overall bank's process landscape (cf. Figure 9).

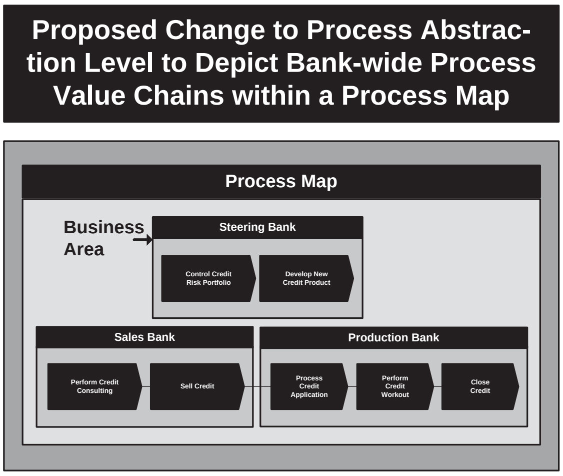

Figure 9: Process Map

Additionally, the bank demanded to group different subprocesses so that these groups would represent relatively autarkic economic services (so called 'value creating (sub)process bundles', cf. Figure 10). The idea was then to recombine these value creating (sub)process bundles under a white-labelling approach with different subprocesses from external bank partners since not all external bank partners wanted to outsource their complete crediting processes to this bank, but wanted to selectively outsource only those subprocesses, which they thought our studied bank could do better (e.g., in terms of costs, quality, cycle time or even related to the management of the involved risks). Thus, in contrary to our initial expectation that we would just have to adapt the PBBs and several attributes, we were also forced to adapt the overall process modelling paradigm to some extent in terms of the control flow and abstraction level paradigms.

With regard to analysis we were indeed able to apply several weakness patterns (e.g., 'Document / Information Comes In' with the communication channel being non-electronic, as well as too many verification steps in several processes) and identify these automatically in the newly modelled process models (Becker et al. 2010a). Thus, we could identify 35 optimisation potentials, partly also being able to automatically calculate cost saving potentials by analysing the PBBs and their specific resource-related attributes (i.e., costs, frequencies etc.).

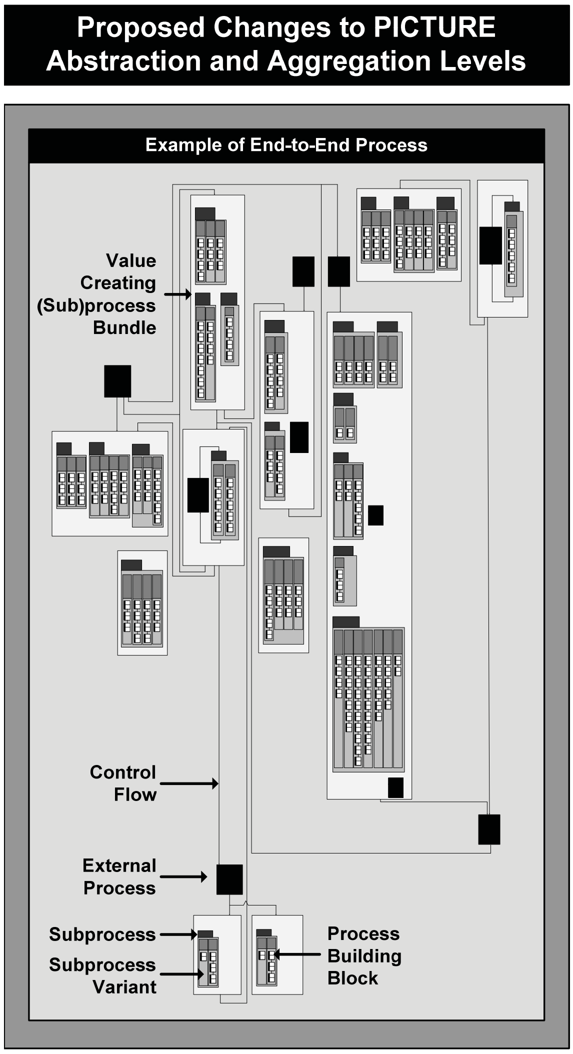

Figure 10: Process Abstraction Levels

6 Demonstration Case 2: Universal Bank

The second iteration of the design science research cycle was conducted in order to ensure the transferability of the adapted PICTURE modelling method to a bank different from the one examined during the first case study. Also, the applicability of PICTURE for modelling all core processes of a bank was to be tested. For this purpose we looked for a banking partner who could provide us with the opportunity to model and analyse all of its core processes, while being different from the first case study banking partner in basic characteristics and at the same time representing a very typical process landscape for banks. We chose a universal bank from a newly industrialised country, namely Russia, thus differing in both bank type and location from the first case study. The bank offered a wide range of typical banking products to its customers, including cash services, credits, deposits, cards and payments. The banking activities were spread over multiple regional branch offices. The bank served 37,000 small and medium enterprises in South Russia, had over 160,000 depositors and issued credits in an overall volume of 94.2 billion roubles in 2008. As of January 1st 2009, the bank employed over 2000 people in 132 subsidiary offices in South Russia.

The process landscape of the bank was previously recorded using textual descriptions and IDEF0 (integration definition for function modelling) models. Approximately 90% of the bank's processes were modelled with the goal of documenting the process landscape as a business blueprint to analyse processes in an ERP system. Therefore, the responsibility for process modelling activities was placed in the IT services department. Under these circumstances we were able to apply the PICTURE process modelling language to most of the banking processes in the areas of cash services, deposits, incoming and outgoing payment processing, cards, and credits for both persons and legal entities and general processes including financial monitoring, account management etc.

The PICTURE process models were created based on IDEF0 models and textual descriptions provided by the bank. The main goal was to transform the textual descriptions into more easily readable and analysable process models. We applied the adapted PBB set for banks, which resulted from evaluation of findings from the first case study. The modelling was conducted using the adapted control flow concept. Furthermore, a visual process map was implemented to provide an overview of the complete process landscape. In addition to testing the transferability of the PBB types to a different setting, we also focused on the attributes assigned to the PBBs, as these attributes specify the properties of each activity and provide core information for a subsequent process analysis. We asked to what extent the attributes, deduced from the application context of a public administration, were also applicable in the banking domain. Therefore the modelling process included the identification of detailed information regarding the process steps, which should be represented with the help of additional analysable attributes esp. with regard to PBBs. Subsequently, this information was mapped to the existing attributes in order to both assess the usefulness of these attributes and propose new attributes, where the existing ones could not satisfy the information needs of the bank.

7 Evaluation of Case 2: Universal Bank

During the course of the first demonstration project, covering a large share of the core daily business processes of the specialised bank, we modelled and analysed 34 banking processes with 84 subprocesses, and 258 process variants.

During the course of the second case study 227 process models were created and subsequently analysed by a team of 8 modellers in an iterative process. These process models comprised 334 subprocesses, 813 variants and documented 2,897 activities in the form of PBBs. We found that some adaptations needed to be made to the set of PBBs in order to abstract from some specific details of the first case study, as well as to account for further bank specifics, not noted during the first case study, due to its limited scope.

On one side, we saw the need to combine several PBBs into a new PBB type on two occasions based on their appearance in the process models (cf. Table 2). This applied to the PBBs 'Forward Document / Information' and 'Document / Information Goes Out', which were combined to

'Document / Information Goes Out', as the modelling team identified that these PBBs were used interchangeably in the created process models and the differentiation between internally forwarding information and externally sending information could be hidden in a separate attribute of the combined PBB. The same applied to the PBB 'Make Demand / Follow Up' and 'Request Document / Information', which were combined to 'Request Document / Information', as the semantic difference was only the communication channel used, which could again be captured in an attribute of the combined PBB.

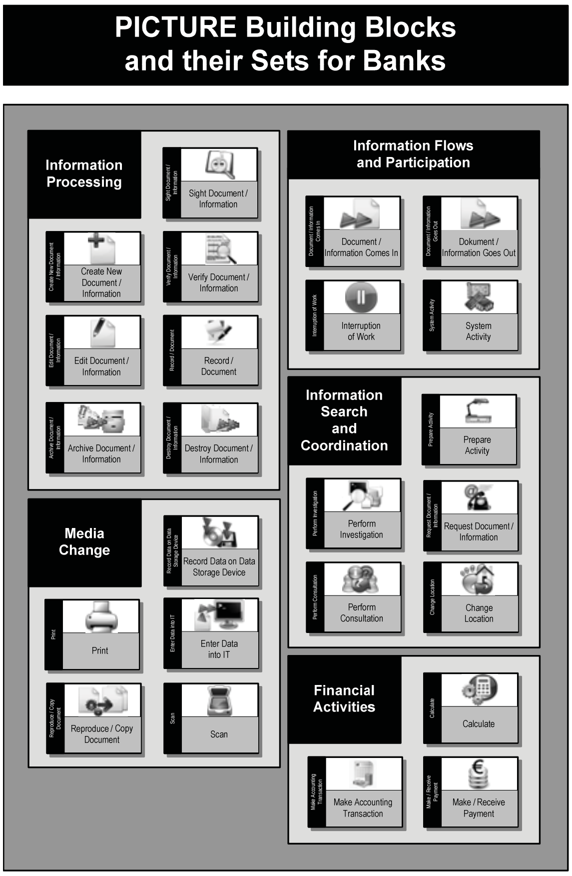

Figure 11: Final Process Building Blocks for Banks

On the other side, we also found that we never used the PBB 'Record / Register' from the original set of PBBs in any of our case studies in banks. Therefore, after extensively analysing the almost complete process landscape of this bank, we omitted this PBB from the set of PBBs for banks. Furthermore, we found that the PBB 'Management Activity' was often mistaken for an activity conducted by a manager, instead of being (correctly) understood as an activity managing further process steps. Thus, the PBB was renamed to 'Prepare Activity'.

Furthermore, we regrouped the PBBs to reflect the vocabulary of the banking sector rather than that of the initial public domain (cf. Table 2). Two PBB groups – 'Information Flows and Participation' and 'Media Change' – were not changed. The group 'Information Search and Coordination' was extended to include the PBB 'Change Location' (previously in the group 'Administrational Work'), as this was perceived more suitable, as changing a location was usually due to a coordination activity with a customer. The remaining PBBs were restructured into the groups 'Information Processing' (covering the former 'Document Processing' group and part of the former 'Administrational Work' group), and 'Financial Activities', including only those PBBs from the former 'Administrational Work' group referring to calculations and financial transactions. The final set of PBBs for the banking sector is depicted in Figure 11.

Additional facts about the processes can be collected with the help of attributes assigned to each block. For example, a possible attribute for the PBB 'Enter Credit Application Data into IT System' is 'Duration'. Without going into the details of the numerous attributes of each PBB, during the course of our project, we found that we also had to change a number of the original attributes (11), remove several attributes specific to public administrations (17) and add new general as well as bank specific attributes (149). Starting out with 163 attributes from the PICTURE modelling language for public administrations we could enhance the attribute set to 304 analysable attributes for the resulting SBPML for banks notation.

8 Final Composition of the Artefact: Case Synthesis

Our initial objective was to create a process modelling language that would be especially suited for the use in banks and more efficient regarding process modelling and analysis in this domain. After three redesigns of the initial PICTURE modelling language, two complete iterations of the design and development, demonstration and evaluation phases of the DSRM approach, and the cooperation with three very different banks, we found that we achieved a relatively stable method that we had to change less and less with each new design. This fact can be demonstrated most easily when taking a look at the evolution of the PBB set over the course of our case studies.

While we started out with a variety of extensions (6), creating 30 bank-specific PBBs, our first and second case evaluation only revealed a few more PBB merges (3 at first 2 later) and 1 PBB omission. Thus, instead of drastically changing with each case, our PBB set for banks consistently converged with less and less changes from 30 to 24 PBBs (cf. Table 1 and Table 2), although the cases studied increased notably with regard to scope and complexity. This is remarkable since the creators of the original PICTURE method personally confirmed us a similar observation from their public sector experience.

For the PICTURE language for public administrations the creators also started out with a variety of PBBs, until their set of PBBs gradually converged to 24 PBBs over the course of many projects in the public sector. According to them it now rarely changes, and adaptations are only necessary when entirely new process areas of public administrations and thus new activities have to be captured (esp. less administrative, but manual activities like making a visual on-site inspection of realty or even gathering field data at rivers and lakes for ecological reports).

Even though we have studied only two cases in depth, we argue that our engineered semantic BPML may not be complete, but is very likely a satisfying solution, since many banks have similar processes and use similar activities compared to our systematically chosen typical bank cases. Thus, assuming that we have a valid semantic BPML specific to banks, we are still confronted with proving if our method is really more efficient for modelling and analysis of bank processes.

Modelling efficiency: Although we did not measure the time and resources that were necessary for modelling processes in comparison to modelling the processes with generic modelling languages (e.g., EPC or BPMN), we observed it to be much shorter. For an actual comparison of the modelling efficiency of processes with the help of the EPC method in comparison to modelling with PICTURE in public administrations we refer to Becker et al. (2006, p. 116). From various projects in the public administration, they came to the result that modelling with PICTURE is at least three times faster than modelling with any form of EPC notation. Using informal argument and logical proof, we claim that the results found by Becker et al. (2006) can also be transferred to the banking sector, since we only altered the BPML slightly, keeping the large majority of its modelling paradigms and simplicity.

Not only is the modelling process faster in itself, as opposed to modelling with common, generic modelling languages. In addition, large parts of the modelling can be done without the involvement of external consultants by the respective bank employees themselves, following the 'model what you do' credo of the PICTURE approach. On one side, this is due to the easily understandable PBBs, which reflect the daily activities of bank employees.

This was one of our key findings after several workshops with the banks' employees. All employees had no prior knowledge of the syntax and semantics of our new process modelling language, but nevertheless were able to interpret the PBBs entirely without any further information from us. On the other side this is due to the

Evolutionary Design of PBB Set for Banks

Category	PBBs for Public Administrations original set from public administration before it was adapted to banking sector	Initial PBB Set for Banks v1.0 after expert interviews and initial study of sample processes from banks
Information Flows and Participation	Document / Information Comes In	Document / Information Comes In
	Interruption of Work	Interruption of Work
		System Activity
	Forward Document / Information	Forward Document / Information
	Document / Information Goes Out	Document / Information Goes Out
Document Processing	Create New Document / Information	Create New Document / Information
	Edit Document / Information	Edit Document / Information
	Record / Register	Record / Register
	Archive Document / Information	Archive Document / Information
		Destroy Document / Information
Administrational Work	Sight Document /Information	Sight Document / Information
	Perform Formal Verification	Perform Formal Verification
	Perform Content Verification	Perform Content Verification
		Record / Document
	Calculate	Calculate
	Make Payment	Make Payment
	Encash / Receive Payment	Encash / Receive Payment
		Make Accounting Transaction
	Change Location	Change Location
Information Search and Coordination	Perform Investigation	Perform Investigation
	Perform Consultation	Perform Consultation
	Make Arrangement / Agreement	Make Arrangement / Agreement
	Make Demand / Follow Up	Make Demand / Follow Up
		Request Document/Information
		Management Activity
Media Change	Print	Print
	Reproduce / Copy Document	Reproduce / Copy Document
	Record Data on Data Storage Device	Record Data on Data Storage Device
	Enter Data into IT	Enter Data into IT
	Scan	Scan
# of PBBs	24	30

Table 1: PBB Evolution Phases 1–2

Evolutionary Design of PBB Set for Banks

Category	1st Refined PBB Set for Banks v2.0 after application at specialised bank (case 1) in core process landscape	Category	2nd Refined PBB Set for Banks v3.0 after application at universal bank (case 2) in almost entire process landscape
Information Flows and Participation	Document / Information Comes In	Information Flows and Participation	Document / Information Comes In
	Interruption of Work		Interruption of Work
	System Activity		System Activity
	Forward Document / Information		Document/Information Goes Out
	Document/Information Goes Out		
Document Processing	Create New Document / Information	Information Processing	Create New Document / Information
	Edit Document / Information		Edit Document / Information
	Record / Register		
	Archive Document / Information		Archive Document / Information
	Destroy Document / Information		Destroy Document / Information
Administrational Work	Sight Document / Information		Sight Document / Information
	Verify Document / Information		Verify Document / Information
	Record / Document		Record / Document
	Calculate	Financial Activities	Calculate
	Make / Receive Payment		Make / Receive Payment
	Make Accounting Transaction		Make Accounting Transaction
	Change Location	Information Search and Coordination	Change Location
Information Search and Coordination	Perform Investigation		Perform Investigation
	Perform Consultation		Perform Consultation
	Make Demand / Follow Up		Request Document / Information
	Request Document/Information		
	Management Activity		Prepare Activity
Media Change	Print	Media Change	Print
	Reproduce / Copy Document		Reproduce / Copy Document
	Record Data on Data Storage Device		Record Data on Data Storage Device
	Enter Data into IT		Enter Data into IT
	Scan		Scan
	26		24

Table 2: PBB Evolution Phases 3–4

simplified approach to modelling control flows, without explicitly using operators and concentrating mainly on a sequential flow view, which constrains the freedom of the modeller and limits model complexity.

Thus, using the adapted PICTURE modelling language in banks, referred to as the new SBPML for banks notation, allows for a faster and more cost-efficient creation of process models. Since no expensive consultants are needed to create process models, the process landscape can be easily kept up to date without much effort by internal bank employees, leading to more up-to-date information with only marginal additional expenses.

Analysis efficiency: With regard to automatically analysing business process models we consider the method to be very valuable. The process models are especially useful for automatically analysing IT investment decisions, for process comparisons, and for IT implementation analyses (e.g., workflow management systems and document management systems because PBBs focus on information flows and document flows). Furthermore, the underlying semantic definition of each PBB allows for the automatic identification of sequences. For example, a print pattern followed by the entering of data into a different IT system indicates a media break within the process. A media break can be defined as a change of the medium used to carry information during information processing. In terms of our case 1, we were able to automatically identify ten processes where employees had to enter data into IT systems after they received documents.

Another type of weakness we were able to detect was how often manual verifications had to be made in a process by analysing the occurrences of the PBB 'Verify Document/Information' (Becker et al. 2010a). In the case of our specialised bank for example we automatically detected 157 verification activities in the modelled processes bearing an optimisation potential through (partial) automation or simplification along the identified processes.

The annotation of attributes allows for automatically deriving the potential of processes with respect to reorganisation initiatives. For example, it is possible to analyse the cost saving potentials of using different communication channels (telephone, fax, letter, e-mail, or face-to-face contacts) with the help of attributes. Frequent processes with incoming information that arrive by phone in 80% of the cases may be serious candidates for reorganisations in order to receive and ultimately also process more information digitally. This kind of analysis is also helpful for human resource requirements planning and organisational documentations. For example, we were able to automatically derive job descriptions and required skills from the process models. Analyses can also be done in terms of which IT system and IT mask knowledge is required, and how much and what client contact is necessary in order to fulfil a specific job responsibility.

With regard to compliance rules, operational risk management and new requirements from the financial crisis management, we were also able to identify the involvement in critical decisions that actually required a four-eyes principle. These analyses are very important for the internal auditing departments of banks. Furthermore, we were able to retrieve information about processes and employees that were involved in handling physical money or transferring money.

9 Summary, Limitations, Contribution and Outlook

The adaptation of the PICTURE method - here referred to as SBPML for banks notation - turned out to be very suitable for our needs in the banking sector. Within both cases, we were able to develop a stable set of PBBs and refine the overall method for describing core banking processes and for analysing weaknesses as described above. The modelling of the processes turned out to be very simple due to the limited set of PBB alternatives. However, the standardisation of PBBs did not limit the individual naming of activities in the context of the process. For example, the actual PBB 'Create New Document / Information' could be renamed individually (e.g., 'Create Payment Document' for a better readability), although the underlying semantic remained the same (due to the PBB 'Create New Document / Information' and its attached resource type 'Payment Document' from the resource model). As one bank employee put it 'we were able to describe our processes in a structured, but still very flexible way without much knowledge about any process modelling rules'.

The resulting SBPML for banks notation meets the specific needs of banks better than generic modelling languages, in that it is easier to comprehend, more efficient, and allows for a semi-automatic analysis of process models (Becker et al. 2010a). Both the modelling and the analysis can be conducted by business professionals with only little initial help from external method experts.

Regarding **limitations**, the SBPML notation so far explicitly focuses on core banking processes. We do not expect to be able to model all types of processes with it apart from core banking processes. So far, we did not try to model general company processes (such as human resources, accounting etc.), found in many types of businesses. Even though we concentrated on core banking processes only, there is still the opportunity to further develop the language to also be able to model general processes as these are partially also highly administrative, structured and repetitive. As a first start, we have only applied the semantic BPML approach in a large share of the core business processes from two typical commercial banks. However, looking at other types of banks (i.e., investment banks) with different core products and activities (e.g., focussing on portfolio risk and asset management), it may be possible that not all processes can be modelled.

Domain-neutral languages have the advantage that they can be applied universally to any type of domain, whereas the usage of our language is limited to the banking sector. SBPML for banks offers less degrees of freedom concerning how to model. It is not possible to choose different abstraction levels or types of processes to be modelled. However, we believe that this new approach is more sophisticated in terms of syntactic evaluations of processes as well as—even more important—in terms of semantic evaluations. Concluding from our case synthesis, SBPML for banks offers a much higher degree of analysis possibilities due to the encapsulation of semantics in attributes and PBBs.

With respect to our **contribution** to the body of knowledge, we have contributed to the advances in the areas of business process modelling theory and practice (Havey 2005, pp. 44-72). In particular, we have contributed by introducing a domain-specific semantic business process modelling approach for banks, which has been based on the PICTURE approach, formerly only specified for public administrations. We have proven that a domain-specific business process modelling approach may well be adapted to a similar domain without many changes. In our case we transferred findings from the public administration sector to the domain of banks, but we argue that we may just as well have tried to adapt the modelling language to insurance companies as these also have very similar processes compared to those of the governmental or banking sector (Becker et al. 2010b). Thus, we have not only proven the generalisability of another approach, but we argue that our new business process modelling specification is also generalisable to any type of bank or even financial sector company—including insurance companies, brokers, stock exchanges etc. as all of these deal with similar activities and underlie a similar governmental and economic ecosystems with regard to regulatory requirements and business process requirements. With regard to practice we have delivered two in-depth case studies as first evidence of the feasibility of our approach for easily modelling and efficiently analysing business processes in banks.

In addition, from a philosophy of science point of view focusing on research methods, we have provided a valid piece of design science research according to Hevner et al. (2004)'s guidelines by creating an innovative and purposeful artefact for a highly relevant tasks in banks (namely automated business process modelling and analysis). Undergoing a rigorous research framework, with multiple iterations, we have demonstrated the usefulness of our artefact within two in-depth case studies. Finally, by applying the design science research methodology (DSRM) (Peffers et al. 2008), we have also provided evidence of the feasibility of the DSRM approach, which can also be seen as an important contribution to the philosophy of IS research debate by itself.

With respect to an **outlook** we suggest further field studies to monitor the use of our artefact in multiple projects and derive new areas of application from these studies. We also suggest further case studies for an in-depth study of the artefact's feasibility and utility regarding multiple purposes in different banking business environments and project settings esp. with respect to the possible types of analyses that are of interest to banks.

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References

van der Aalst W. M. P., ter Hofstede A. H. M., Weske M. (2003) Business Process Management: A Survey. In: Proceedings of the 1st International Conference on Business Process Management. Eindhoven, pp. 1–12

Becker J., Kahn D. (2003) The Process in Focus. In: Becker J., Kugeler M., Rosemann M. (eds.) Process Management. Springer, Berlin, pp. 1–11

Becker J., Algermissen L., Falk T., Pfeiffer D. (2006) Reorganization Potential in Public Adminsitrations: Identification and Measurement with the PICTURE-Approach. In: Proceedings of the 5th International EGOV Conference. Krakau, pp. 111–119

Becker J., Algermissen L., Pfeiffer D., Räckers M. (2007) Local, Participative Process Modelling: The PICTURE-Approach. In: Proceedings of the 1st International Workshop on Management of Business Processes in Government. Brisbane, pp. 33–48

Becker J., Weiß B., Winkelmann A. (2009) Developing a Business Process Modeling Language for the Banking Sector: A Design Science Approach. In: Proceedings of the 15th Americas Conference on Information Systems (AMCIS 2009). San Francisco

Becker J., Bergener P., Räckers M., Weiß B., Winkelmann A. (2010a) Pattern-Based Semi-Automatic Analysis of Weaknesses in Semantic Business Process Models in the Banking Sector. In: Proceedings of the 18th European Conference on Information Systems (ECIS 2010). Pretoria, South Africa

Becker J., Weiß B., Winkelmann A. (2010b) Reflections On the Design of Domain Specific Semantic Business Process Modeling Languages – An Evolutionary Approach. In: Proceedings of the Fachtagung Verwaltungsinformatik (FTVI 2010). Koblenz, pp. 98–100

Becker J., Weiß B., Winkelmann A. (2010c) Transferring a Domain-Specific Semantic Process Modeling Language – Findings from Action Research in the Banking Sector. In: Proceedings of the 18th European Conference on Information Systems (ECIS 2010). Pretoria

Becker J., Weiß B., Winkelmann A. (2010d) Utility vs. Efforts of Business Process Modeling – An Exploratory Survey in the Financial Sector. In: Proceedings of the 5th Multikonferenz Wirtschaftsinformatik (MKWI 2010). Göttingen

Blechar M. J. (2007) Magic Quadrant for Business Process Analysis Tools. Gartner RAS Core Research Note G00148777. Gartner, Inc. Stamford

Celino I., de Medeiros A. K. A., Zeissler G., Oppitz M., Facca F. M., Zoeller S. (2007) Semantic Business Process Analysis. In: Workshop on Semantic Business Process and Product Lifecycle Management (SBPM). Innsbruck, Austria, pp. 44–47

Cocheo S., Harris K. (2007) Key Customers Today and Tomorrow. In: ABA Banking Journal 97(3), pp. 3–6

Gupta D., Prakash N. (2001) Engineering Methods from Method Requrements Specifications. In: Requirements Engineering 6(3), pp. 135–160

Havey M. (2005) Essential Business Process Modeling. O'Reilly, Cambridge

Heuskel D. (1999) Wettbewerb jenseits von Industriegrenzen. Aufbruch zu neuen Wachstumsstrategien. Campus, Frankfurt am Main

Hevner A. R., March S. T., Park J., Ram S. (2004) Design Science in Information Systems Research. In: MIS Quarterly 28(1), pp. 75–105

Hung R. Y. Y. (2006) Business Process Management as Competitive Advantage: A Review and Empirical Study. In: Total Quality Management Business Excellence 17(1), pp. 21–40

IBM (2005) The paradox of Banking 2015: Achieving more by doing less. http://www-935.ibm.com/services/us/imc/pdf/ge510-6225-banking-2015.pdf. Last Access: 2009-10-13

IDS Scheer (2007) Business Process Report 2007. Technical Report. IDS Scheer. Saarbrücken

Iochpe C., Chiao C., Hess G., Nascimento G., Thom L., Reichert M. (2007) Towards an Intelligent Workflow Designer based on the Reuse of Workflow Patterns. In: Proceedings Simpósio Brasileiro de Sistemas Multimídia e Web. Gramado

Lin Y. (2008) Semantic Annotation for Process Models: Facilitating Process Knowledge Management via Semantic Interoperability. Dissertation, Norwegian University of Science and Technology, Trondheim

Lindsay A., Downs D., Lunn K. (2003) Business Processes: Attempts to Find a Definition. In: Information and Software Technology 45(15), pp. 1015–1019

Mendling J., Reckers J., Reijers H. A. (2009) Process Modeling Quality. A Framework and Research Agenda. BPM Center Report 2009-02. BPM Center. http://BPMcenter.org

Papastathopoulou P., Avlonis G., Indounas K. (2001) The Initial Stages of New Service Development: A Case Study from the Greek Banking Sector. In: Journal of Financial Services Marketing 6(2), pp. 147–161

Peffers K., Tuunanen T., Rothenberger M., Chatterjee S. (2008) A Design Science Research Methodology for Information Systems Research. In: Journal of Management Information Systems 24(3), pp. 45–77

Pfeiffer D. (2008) Semantic Business Process Analysis: Building Block-based Construction of Automatically Analyzable Business Process Models. Dissertation, University of Muenster, Muenster

Ralyté J., Deneckère R., Rolland C. (2003) Towards a Generic Model for Situational Method Engineering. In: Proceedings of the 15th International Conference on Advanced Information Systems Engineering. Klagenfurt/Velden, pp. 95–110

Ralyté J., Rolland C., Deneckère R. (2004) Towards a Meta-Tool for Change-Centric Method Engineering: A Typology of Generic Operators. In: Proceedings of the 16th International Conference on Advanced Information Systems Engineering. Riga, pp. 202–218

Recker J. C., Rosemann M., Indulska M., Green P. (2009) Business process modeling – a comparative analysis. In: Journal of the Association of Information Systems 10(4), pp. 333–363

Simon H. A. (1996) The Science of the Artificial. MIT Press, Cambridge

Spath D., Engstler M., Praeg C., Vocke C. (2007) Bank Zukunft 2007: Mit Prozessexzellenz und Vertriebsinnovationen die Bank der Zukunft gestalten. Stuttgart

Thom L. H. (2006) A Pattern-Based Approach for Business Process Modelling. Dissertation, Universidade Federal do Rio Grande do Sul, Porto Alegre

Thomas O., Fellmann M. (2007) Semantic Business Process Management: Ontology-Based Process Modelling Using Event-Driven Process Chains. In: International Journal of Interoperability in Business Information Systems 1(2), pp. 29–44

Vergidis K., Tiwari A., Majeed B. (2008a) Business Process Analysis and Optimization: Beyond Reengineering. In: IEEE Transactions on Systems, Man and Cybernetics 38(1), pp. 69–82

Vergidis K., Turner C. J., Tiwari A. (2008b) Business Process Perspectives: Theoretical Development vs. Real-World Practice. In: International Journal of Production Economics 114(1), pp. 91–104

Jörg Becker, Irina Thome, Burkhard Weiß
European Research Center for Information Systems (ERCIS)
University of Münster
Leonardo-Campus 3
48149 Münster
Germany
{joerg.becker | irina.thome | burkhard.weiss}@ercis.uni-muenster.de

Axel Winkelmann
Institut für Wirtschafts- und Verwaltungsinformatik
University of Koblenz-Landau
Universitätsstraße 1
56070 Koblenz
Germany
winkelmann@uni-koblenz.de