Business Process Improvement by Applying Reference Process Models in SOA – a Scenario-based Analysis

Oliver Holschke, Philipp Gelpke, Philipp Offermann, Christian Schröpfer

Institut für Wirtschaftsinformatik und Quantitative Methoden
Technische Universität Berlin
Straße des 17. Juni 135
10623 Berlin
oliver.holschke@sysedv.tu-berlin.de, cpgelpke@cs.tu-berlin.de,
philipp.offermann@tu-berlin.de, christian.schroepfer@sysedv.tu-berlin.de

Abstract: Several factors may force enterprises to modify their business processes: they are threatened by competition; they need to develop new process solutions to fulfil customer needs; they have to react to organizational change; and more. In order to efficiently change business processes, reference models as sources of to-be business processes that are to bring about economic improvements can be used. While in the past the application of reference process models would merely provide a new process model without addressing the necessary efforts of changing the technical solutions beneath it, the concept of service-oriented architecture (SOA) may significantly reduce these efforts by aligning services to business activities. The presumed ease of readily deployable business processes will then strongly promote the increased use of reference process models in business process optimization. In order to gain more insights into the potential of using reference processes in an SOA environment we carried out an analysis of a business process improvement scenario. We classified the modification operations of implementing reference processes in the scenario and propose an evaluation method for the implementation effort based on a cost model.

1 Introduction

Over the past years, the role of business processes has been continuously growing. With an increasing speed of changes in market conditions business processes have to be adaptive and flexible to meet business demands. There are several factors why enterprises may be forced to modify their business processes: they are threatened by competition; they need to develop new process solutions to fulfill customer needs; they have to react to organizational change; and more.

The sources of to-be business processes that are to bring about economic improvements once integrated can be found in reference models. These are developed either internally or outside of the enterprise, e.g. by industry standard organizations such as the TeleManagement Forum [TMF05], the Supply-Chain Council [SCO06] and others.

Their application is an effective method to speed-up business process improvement, adapt to industry-specific best-practices and/or comply with industry-specific and cross-industry standards.

In recent years, a lot of research work has been done on the role of reference process models in business process management, e.g. [Bec04], [Fet04], [Aal05]. In [Fet06] an overview of business process reference models is given and reference models are classified. [Küs06] presents a concrete example for the improvement of a business process by applying a reference process model.

In previous work the application of reference process models would merely provide a new process model without addressing the necessary efforts of changing the technical solutions beneath it. These efforts have to be considered for the economic evaluation of reference process models [Tho06]. The concept of service-oriented architecture (SOA) may significantly reduce these efforts by aligning services to business activities. The presumed ease of readily deployable business processes will then strongly promote the increased use of reference process models in business process optimization. Recent work on business process modeling, configuration and execution in SOA support this assumption, e.g. [Tho07], [Zim05].

In order to gain more insights into the potential of using reference processes in an SOA environment we carried out an analysis based on a business process improvement scenario. We developed a method to implement reference process models, derived a classification scheme of business process transformation operations and propose a method for the evaluation of transformation effort based on a cost model.

The remainder of this paper is organized as follows: Section 2 presents our analysis approach and the scenario from the car rental industry. Section 3 describes how reference processes can be applied to improve a basic process and what transformation steps are required on a modeling notation level. In section 4 an overview of the SOA in which the reference processes were implemented is given. The actual modification operations and implementation of the reference processes are presented in section 5. In section 6 the classification of the modification operations is done and an effort measurement method proposed. The findings of our contribution are concluded in section 7.

2 Analysis Approach and Scenario

As our objective is to analyze business process improvements in an SOA environment we do not follow a green-field approach for the application of reference process models but take an implemented basic business process as a starting point. This basic business process may represent an as-is business process in a company. Starting from there the process shall be improved in various ways by applying reference process models [Tho05].

For our analysis we have modeled a basic process and three reference processes to be used as improved target processes. In order to systematically create these, we applied construction methods available in the reference modeling literature [Sch98] [Bro03] [Tho06]. Once the reference processes are finalized, the transformation of the basic process to either one out of the three reference processes is done.

The basic process is supported by an IT infrastructure designed by the principles of an SOA. Section 4 gives an overview of the SOA design. Process transformation in this context means implementing the modified process model in the SOA environment starting from the implementation of the basic process.

The focus of our analysis is the methodical approach of implementing the process transformation and the classification of different transformation operations based on several criteria (e.g. complexity of the task). These transformation operation classes can then serve as a basis for evaluating the effort required when using reference process models to improve a basic business process.

For our analysis we selected a business scenario from the car rental industry. The core business processes of a car rental company are car reservation, car pick-up, and car return. The specific business process we analyzed is the returning of a rental car to the car rental company. The improvements introduced by the reference processes affect different activities along the process of returning a rental car. The affected activities and further process details will be given in the following section.

3 Applying Reference Process Models

We constructed the reference models in the scenario following the steps of methods proposed in [Sch98], [Bec00] and [Fet02]. The construction process of reference processes consists of four phases: 1. problem definition, 2. problem domain analysis, 3. construction, and 4. evaluation. Phases 1 to 3 are covered in section 3.2. An evaluation method is proposed in section 6. Our inductive construction approach was based on literature reviews, interviews and real-life observations. During our literature review we analyzed the terms and conditions of leading car rental companies as well as industry analyses. Based on this we developed a first draft of the basic car return process and identified process improvement potentials. Then we conducted interviews with employees and experts in the car rental industry and constructed the reference processes.

The basic process model is described in 3.1. In section 3.2 the reference process models for improving the business process and the method of developing them are presented and required modifications on a process level are discussed. The applied construction method of developing the improved business processes is analogy construction. For simplicity we analyzed the implementation of each reference process separately.

3.1 Basic Car Return Process Model

The basic car return process is a simplified process model for handling the return of a car in a car rental company. The process model of the basic car return process is presented in figure 1 using the Business Process Modeling Notation (BPMN).

The process is initiated at the local service by the return of a car. The car is inspected in presence of the customer and claims are recorded. The invoice is created automatically based on the rental data and the entered claim information. The valuation of claims is based on a standard claims list and the retention respectively. If there are no claims the car is released. If claims occurred, a claim report is generated. The claim report is submitted to the claim settlement department which is responsible for contacting the insurance company and entering the regulation information. Finally the case is documented and the car is repaired and released.

There are three participants in the process: the local service, the accounting and the claims settlement. The local service is the point of contact for the customer for renting and returning a car. For simplicity there is only one local service represented in the process. The accounting and claim settlement departments can either also be local or centralized in the company. User interactions within the process are colored grey.

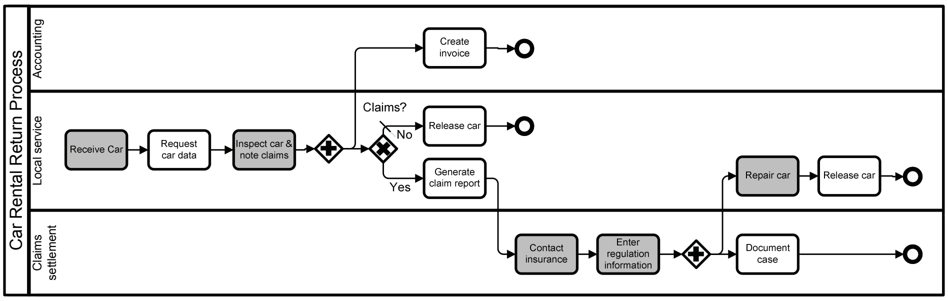

Figure 1: Basic Car Return Process Model

3.2 Reference Process Models

The process improvements embedded in the constructed reference processes 1 to 3 are the following: 1. increase process flexibility by adding an outside business hours return option, 2. increase process efficiency by reducing renting cycle time, and 3. increase process efficiency by B2B-integration.

Reference process 1: Additional Return Option. Offering an outside business hours return option increases customer satisfaction. In the basic process the customer has to be present during the inspection of the car. This implies that returning a car is only possible during business hours of the local service. In reference process 1 there is the additional option to return the car outside business hours of the local service. The process is presented in Figure 2. This reference process implements an additional activity for contacting the customer after inspection of the car in the case that claims occurred.

The realization of this additional return option on BPMN level requires the addition of a people activity "Contact customer" and two XOR-gateways to split the process flow before contacting the customer and to merge the process flow afterwards. The condition for the XOR-gateway that splits the process flow before the "Contact customer" activity is based on the presence of the customer during inspection. This information is additionally entered in the user interface of the "Inspect car & note claims" activity.

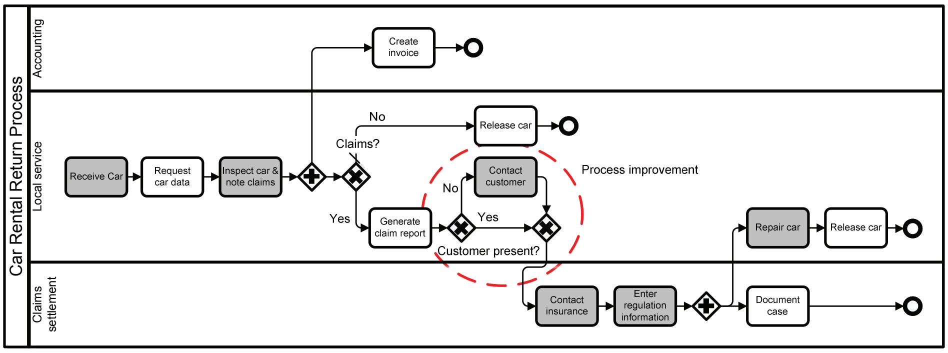

Figure 2: Reference Process Model with Additional Return Option

Reference process 2: Reduced Renting Cycle Time. Short renting cycle times mean high utilization of rental cars. Stand-still times of cars have to be kept short. In the basic process all damages on cars are repaired. Further the repair of a car is not initiated until the claim is settled with the insurance. In reference process 2 the utilization of cars is increased by not repairing minor damages immediately, e.g. scratches, and by initiating the repair of cars with major damages directly after the inspection without waiting for the settlement with the insurance.

The realization of this reduced renting cycle time on BPMN level requires the addition of an inclusive-OR gateway and the moving of the "Repair car" and "Release car" activities. The condition in the inclusive-OR gateway is based on the occurrence and the classification of claims as minor or major. This information is additionally entered in the user interface of the "Inspect car & note claims" activity.

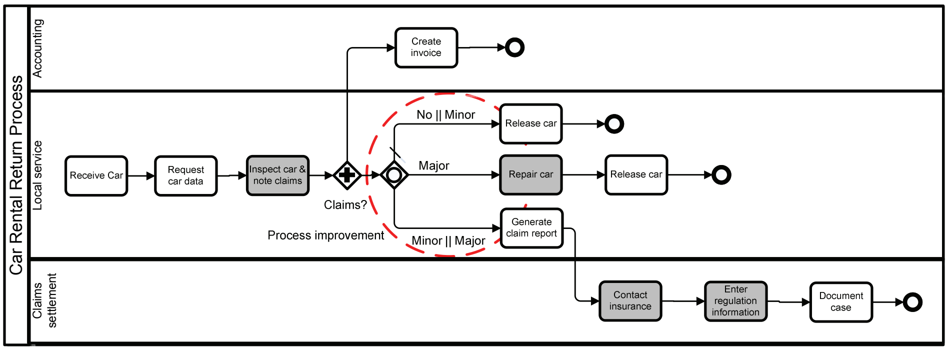

Figure 3: Reference Process Model with Reduced Process Cycle Times

Reference process 3: B2B integration. With the electronic exchange of data between businesses, process cost reductions can be achieved, e.g. avoiding input of the same data multiple times. In the basic car return process information exchange between the car rental company and the insurance company is realized via email. The settlement information is entered manually afterwards. In reference process 3 we improved the basic car return process by integrating the insurance company via a web service. The information is validated before initiating the information exchange with the insurance. Then the information is sent to the insurance company and after processing, the settlement information is sent back to the car rental company.

The realization of the B2B integration on BPMN level requires the substitution of the user interaction "Enter regulation information" with the "Information exchange insurance" activity and the renaming of the "Contact insurance" activity to "Validate information".

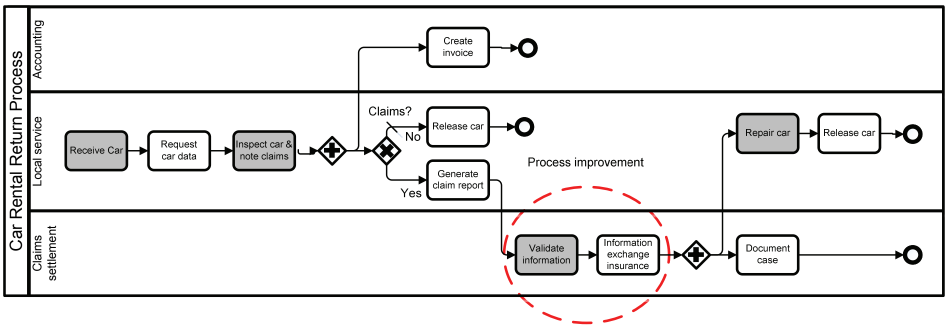

Figure 4: Reference Process Model with B2B-Integration

4 Overview of the SOA environment

The design of the SOA supporting the car return processes is based on the layered SOA model presented in [Hol07]. Figure 5 presents a mapping of the technical components in the scenario to the layers in the model.

We used the modeling software Intalio|Designer [Int07] for modeling the processes in BPMN [OMG06]. The BPMN process models represent the business process layer in the SOA. Intalio|Designer is further used for the generation of Web Services Business Process Execution Language (WSBPEL) from the BPMN process model. WSBPEL [OAS07] is used for web service orchestration and choreography. The WSBPEL code is executed on the Intalio|Server software.

Web services [W3C04] provide the functionality required in the car return processes. We identified the functionalities creating an invoice, administrating process related data, generating documentation files, and controlling application execution on a client computer and aligned them to the web services CarBilling, CarData, CarDocument and ApplicationExecution. The web services integrate the applications JBilling for invoicing, OpenOffice for word processing and Mozilla Thunderbird for email.

Together with the workflow engine and the task management services, both components of the Intalio|Tempo software supporting workflow functionality and user integration, the web services build the services & composites layer in the SOA.

Intalio|Designer, Intalio|Server and Intalio|Tempo are part of the Intalio|BPMS, an open source business process management system. The Intalio|BPMS software runs on the Apache Geronimo server runtime framework for Java applications. The web services run on the web services engine Apache Axis 2 that relies on the Apache Tomcat web server.

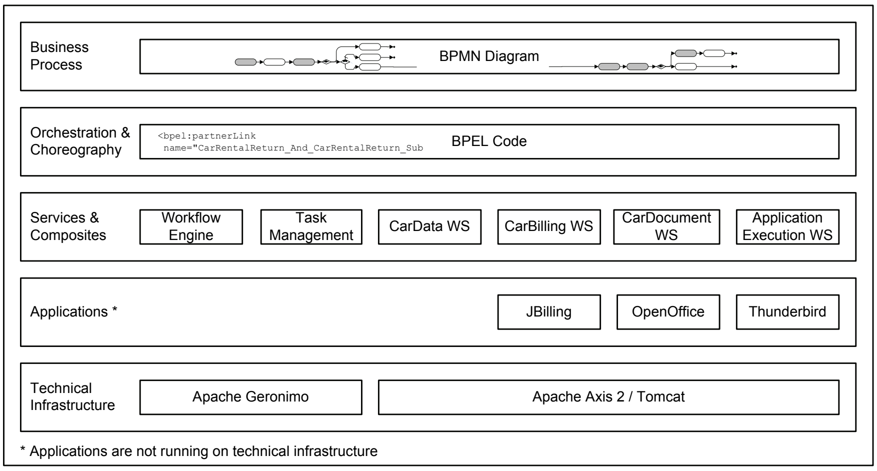

Figure 5: Layered SOA Model of Scenario Components

5 Implementing the Reference Process Models

The focus of implementing the reference process models in the SOA environment lies on the business process, orchestration & choreography and services & components layer. Modifications on the application and technical infrastructure layer are not required in our scenario.

As our reference process models are business-driven we start with the modification of the BPMN diagram in Intalio|Designer. In this work step BPMN elements are added, deleted, moved and connected with drag & drop operations in the modeling software.

Based on the modified BPMN diagram we derive the required modifications in the functionality provided by the web services. If functionality description, activity name, in- and output match the descriptions of an existing web service it can be reused. Otherwise a new web service has to be designed.

Finally, we adapt the web service orchestration and choreography to the modified or new designed web services. In this work step the web services are integrated to the BPMN diagram via their WSDL descriptions, data formats for message flows (typically integrated as XML schema definition files) are adapted and data mappings between messages are modified. If additional data input or output is required by the process the user interfaces are modified, which are realized via XForms in Intalio|Tempo.

We implemented each of the reference processes presented in 2.3 using this method. Due to the limitations of this paper we only present a detailed description of implementing reference process 3.

According to the method presented above we implemented the modification in the following order: BPMN model modifications, web service modifications, web service integration. The left hand column in Figure 6 presents the detailed work steps of implementing reference process 3.

In the BPMN model the user interaction “Enter regulation information” is substituted with the task “Information exchange insurance” and connected via sequence flows to its parent and child activity. The “Contact insurance” task is renamed to “Validate information”.

As there is no web service available in the scenario providing the functionality of data exchange with the insurance company, a new web service has to be designed and deployed on the server. The actual implementation of the web service is kept simple in the scenario as it is not relevant to our analysis.

The integration of a web service in a BPMN model is dependant on the modeling software used. In general the information provided by the Web Service Description Language (WSDL) document of the web service has to be integrated in the BPMN diagram.

In Intalio|Designer a WSDL port is represented as a separate pool in the BPMN diagram. In this pool a WSDL operation can be created which can be connected to a task in the BPMN diagram via message flows. The message flows define the format of the SOAP messages for calling a web service operation. As message formats and message flows have been modified, related data mappings have to be adapted.

Work Steps of Implementing Reference Process 3	Classification
BPMN Model Modifications	
1. Delete "Enter insurance data" task	BPMN simple
2. Create new task "Information exchange insurance"	BPMN simple
3. Connect new task via sequence flows with parent and child tasks	BPMN simple
4. Rename "Contact insurance" task to "Validate information"	BPMN simple
Web Service Modifications	
1. Design and implement new Web Service for data exchange	Web Service
2. Deploy web service on the server	Web Service
Web Service Integration	
3. Copy WSDL-file from web server	WSDL
4. Save <types></types> content in separate XSD-file	XSD complex
5. Add <schema><import schemaLocation="XSD-file/></schema> in WSDL-file	WSDL
6. Import XSD-file in Intalio process explorer	XSD simple
7. Import WSDL-file in Intalio process explorer	WSDL
8. Drag WSDL-port from process explorer to process diagram	BPMN complex
9. Rename and format pool created for WSDL-port	BPMN complex
10. Drag WSDL-operation from process explorer to pool created for WSDL-port	BPMN complex
11. Create message flow for request message from new task to Web Service	BPMN complex
12. Create message flow for response message from web service to new task	BPMN complex
13. Drag XSD message format of request message to message flows in process diagram	BPMN complex
14. Drag XSD message format for response message to message flow in process diagram	BPMN complex
15. Initialize request message format	Data mapping
16. Create data mapping for request message in data mapper	Data mapping
17. Create data mapping for response message in data mapper	Data mapping

Figure 6: Work Steps to Implement Reference Process 3

6 Classification of Modification Operations and Effort Analysis

The modification operations of implementing the reference processes can basically be classified according to the layer in the SOA model they affect. In our scenario this classification is as follows: BPMN modifications, WSBPEL modifications and web service modifications. We refined this general classification with criteria for measuring the effort of an operation. This includes the evaluation of the required proficiency in the modeling tool, the required proficiency in the modeling and execution language, and the understanding of web services and its building blocks (e.g. SOAP, WSDL) of each operation.

We found the following categories: simple BPMN modifications, complex BPMN modifications, simple XSD modifications, complex XSD modifications, data mapping modifications, WSDL modifications, XForms modifications, and web service modifications.

Simple BPMN modifications include adding, deleting, moving, and connecting BPMN elements in the BPMN diagram. They require basic knowledge of BPMN modeling. **Complex BPMN modifications** comprise setting element specific attributes of BPMN elements, e.g. task types, and integrating web services to the BPMN diagram.

Simple XML Schema Definition (XSD) modifications include the definition and re-definition of simple data types used in messages. **Complex XSD modifications** comprise the definition and re-definition of composed data types and creating new message formats. **Data mapping modifications** include initialization of data in messages and mapping data provided by a message to be copied to another message. Further data-based condition flows require data mappings of the input data to the condition.

WSDL modifications include the integration of the composites of WSDL documents in the process model. **XForms modifications** include the design and integration of user interfaces in the process model. **Web service modifications** include the modification or re-design of web service functionality. We do not further analyze these modifications, as they depend on the implementation and functionality of a web service.

The classification of the modification operations of implementing the reference process 3 according to this scheme are presented in the right hand column of figure 6.

We propose an evaluation of the implementation effort of reference process models based on the classification scheme presented above. A practical approach is to evaluate the required proficiency in the modeling tool, the required proficiency in modeling language and execution languages, and the understanding of web services and its building blocks (e.g. SOAP, WSDL) for each operation using a cost model that assigns cost units to the classes in the scheme.

In a cost model in which higher cost means a higher implementation effort of a modification operation, we evaluate the classes of modification operations as follows: BPMN simple (1 unit), BPMN complex (3 units), XSD simple (2 units), XSD complex (4 units), Data mapping (4 units), WSDL (5 units), XForms (5 units), Web services (-).

This evaluation is based on our experience from the implementation of the three reference processes in the SOA environment. The absolute cost is less relevant than the relation between the assigned costs, as all reference models are evaluated based on the same cost model. We recommend a further refinement of the cost model based on the experience from real-life business process improvement projects.

We evaluated the implementation effort of the three reference process models as follows:

- Implementing reference process 1: 24 modification operations → 57 cost units
- Implementing reference process 2: 13 modification operations → 30 cost units
- Implementing reference process 3: 20 modification operations → 58 cost units

The implementation of reference process 1 and 3 require roughly the same transformation effort. Although the transformation of the basic process to reference process 2 implies modifications with relatively high impact on the BPMN diagram, less transformation operations are needed on the lower SOA layers and the transformation operations require less effort. Future work can provide a comparison with graph similarity theory based on graph transformation costs. While our work focuses on transformation costs of reference process models, comprehensive economic evaluation requires identifying those reference processes that lead to optimal cost reductions for a specific business in general. The proposed approach may also be extended by an EPC or C-EPC based modeling layer in order to integrate with standard enterprise software [Ros05].

7 Conclusion

In this paper we analyzed a scenario for business process improvement by applying reference models in an SOA environment. In the scenario we implemented three reference process models with a basic process model as a starting point. We classified the required transformation operations for implementing the reference process models and proposed a method for evaluating the implementation effort based on a cost model.

Our results are meaningful for the use of reference models in business process improvement as they provide a systematic approach to planning, implementing and evaluating business process transformations. The classification scheme and effort evaluation method we presented will contribute to a better understanding of the implementation of reference process models and promote their usage in the future.

We further showed the relative ease of transforming business processes in an SOA. Though most transformation operations in our scenario require a profound knowledge in the standards and the modeling software as well as good understanding of an SOA, only basic programming skills are required. In order to assess the applicability of our approach in real-world enterprise scenarios additional processes in the field of software development and architecture have to be considered.

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