Construction of a Process Reference Model for a Fare Collection Business

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Abstract

Reference modeling has gained much attention in universities and in the business world in the last decades. The concept itself it's not new and it has already been applied in some mature areas like software engineering. Reference models main objective is to boost the development of particular models and to assure their quality. Some of these models are quite known such as SCOR for the supply chain industry or eTOM for the telecommunications business industry. However not all the business industries have been rewarded with such significant developments regarding the construction and reuse of business process reference models like the public transportation industry. To fulfill this need we propose the construction of a reference model for the fare collection business taking into consideration the most recent technological efforts in this area such as the utilization of contactless cards.

To achieve the expected model we propose the utilization of an empirical based construction method based on the domain knowledge captured from other particular models. The resultant model must deal with variability representation based on the mechanisms provided by ADOM approach to guide the reuse process. Finally we will demonstrate model applicability by applying it to the construction of organization-specific models.

Keywords: fare collection business; business processes; reference model; reuse; specific model.
1 Introduction

Reference models are also called universal models, generic models or model patterns (Fettke, Loss & Zwicker, 2005). The main objective of reference models is to streamline the design of enterprise-individual (particular) models by providing a generic solution. The application of reference models is motivated by the ‘Design by Reuse’ paradigm (Rosemann & van der Aalst 2005). The aim of this dissertation is to provide a process reference model for the fare collection business in the public transportation industry to improve the construction of enterprise specific models in the context of information systems development projects. The proposed model must take into consideration the most recent technological efforts in this area such as the utilization of contactless smart cards. In this paper we will first provide an overview of the existing related work already done in this area, and then we will detail the solution for our problem through implementation in an appropriate modeling tool. Finally we explain the methods and criteria applied to evaluate the proposed solution and we finish this thesis with some conclusions regarding the solution itself and the reference modeling subject.
2 Research Overview
To achieve the expected model we did some research in the reference modeling and enterprise architecture research fields. Reference modeling main objective is to provide methods, tools and principles to assist the modeling task of generic artifacts while Enterprise Architecture discipline studies how to represent the different aspects of an enterprise through a set of frameworks.

2.1 Enterprise Architecture
Enterprise representation is usually split among different sub architectures which are: as organizational architecture, business processes architecture, informational architecture, applications architecture and technological architecture. However, in the scope of this thesis, we are only interested in the business and informational architectures. We did this to clarify the concepts and primitives behind each of the stated architectures. We came to the conclusion that the main concepts that support these two architectures are: business processes, data sources (also referred as process resources in some works), business entities and actor roles.

2.2 Reference Modeling
First of all we started the investigation under this subject by clarifying the reference model definition. From all the authors definitions we conclude that a reference model must have at least the following features: universality (for a certain domain), best-practice (for a certain domain) and reusability.

Secondly, to guide the research activity in reference modeling subject we used the research framework of Fettke & Loos (2007). This framework divides reference modeling according to four different perspectives. We didn’t focus on the context research subject because the modeling tool was already established for the current work.

Figure 1 – Reference Modeling Perspectives
2.2.1 Methods
A modeling method provides procedures by which a language can be used. Reference modeling methods can be distinguished with regards to supporting the developing or application process of a reference model.

From the available literature we have found at least five construction methods but they are all quite generic and some of them can only be applied for the construction of configurative reference models. However we highlight the works from Ahlemann & Gastl (2007) and Nes (2007). Ahlemann & Gastl (2007) work refers to a construction process model based on evidence captured from empirical sources and was already validated in some ongoing reference model construction initiatives. The second construction method is an improvement of the reference modeling processes identified by Fettke & Loos (2007), however there’s a significant contribute regarding a study of techniques from product line engineering which can be applied in reference modeling to deal with variability representation.

2.2.2 Languages
A reference modeling language provides a set of constructs and rules that show how to combine the constructs to model real-world domains. BPMN, UML and EPC are quite known examples of process modeling languages but they lack variability representation and reuse guidance which is very important if we want to provide the model users with a reusable asset. To allow variability representation several authors have purposed particular mechanisms that extend or modify existing modeling notations such as C-EPC which is an extension of the well known EPC. Another example consist in a set of multiplicity indicators from ADOM which was proposed by Reinhartz-Berger, Soffer & Sturm (2005) to guide the reuse process of reference models through specialization. Each of these mechanisms are built according to a specific design principle to
assist the reuse process which can be by adoption, by aggregation, by instantiation, by specialization, by configuration or by analogy.

2.2.3 Models
Reference models represent classes of domains but they usually have a different scope or purpose. While the majority of these models are constructed to represent a specific industry domain such as eTOM for the telecommunications industry, others are constructed according to a more functional scope like SCOR for the logistics business. Several authors have proposed classification criteria for better understanding of these models. In this dissertation we have applied the classification framework of Fettke, Loss & Zwicker (2005) to 8 different reference models. Classification criteria can be found in the following figure.

![Figure 3 – Reference Models Classification Framework (Fettke, Loos & Zwicker, 2005)](image)

3 Proposed Solution
After analyzing the state of the art solutions in reference modeling area we have decided to construct the proposed model by following the orientation from the empirical construction process of Ahlemann & Gastl (2007) because we wanted to provide a reference model based on the knowledge captured from two distinct organizations. However we have refined the original process model to highlight some activities instead of others. We have also included a new activity for commonality and variability identification which we consider of extreme importance to identify the reference model processes and entities in a more systematic approach. This method consists of 4 distinct phases: Planning, Construction, Validation and Practical Testing.

Giving the lack of other business specific models to support the construction process we came to the conclusion that we didn’t have enough domain knowledge to represent all the existing variability. So, we have decided to build the reference model according to the specialization design principle. As we already know from the literature, specialization doesn’t provide any reuse guidance at all. To assist the reuse process we have designed reference processes using BPMN modeling language combined with multiplicity indicators from ADOM proposed by Reinhartz-Berger, Soffer & Sturm (2005).
3.1 Implementation

All the concepts identified in section 2.1 have been modeled through a System Architect repository. For each concept identified earlier a definition type was created to extend existing properties and relationships. Each definition type has three different sets of properties: identification properties, reference modeling specific properties and relationships between other EA primitives. We have also introduced the concept of views to allow model visualization from different user perspectives.

![Reference Model Views](image)

Figure 4 – Reference Model Views

Business architecture is established in a 3 level hierarchy. In the first hierarchical level we have four main functional areas: Sales, Operations, Resource Management and Financial & Asset Management. Each of these areas is further decomposed into level 2 business processes with a well defined business goal. For instance, the Sales business area comprises: Contract Selling, Contract Cancellation, Other sales and Credit Refund. Finally each process can be even further decomposed into level 3 processes which we call activities in this thesis. Level 2 Processes also have an associated BPMN diagram for better understanding of the logical flow between business process activities.

![Business Processes Hierarchy](image)

Figure 5 – Business Processes Hierarchy
Informational Architecture is composed by business entities. All entities and their relationships are supported by an ER model diagram representation. Entities are organized according to domains also called aggregated business entities in this thesis.

3.2 Reuse

Reference model reuse process is supported according to the specialization design principle. We have followed this principle because we cannot define standard behavior for all activities. In other words we don’t specify ‘How’ the activities are done, unless they are mandatory and don’t require further decomposition. This kind of detail must be supplied while instantiating the reference model to each organization specific model. To assist the reuse process we have extended process symbols to support the multiplicity indicators of ADOM suggested by Reinhartz-Berger, Soffer & Sturm (2005). A multiplicity indicator of an activity specifies a range for the number of specializations of that activity that may be included in an instantiated model. The multiplicity indicator has a lower and an upper constraint (denoted as <min, max>). If the lower constraint is zero than the activity is optional in the process, and may be omitted in an instantiated model. Otherwise, a specialization of the activity must be included. The upper constraint specifies the maximal number of specializations of that activity that are allowed in an instantiated model (Reinhartz-Berger, Soffer & Sturm, 2005).

![Figure 6 – Contract Selling Reference Process](attachment:image)

4 Reference Model Validation

As we already know from previous research work, reference models main objective is to enable and support the creation of organization specific models. This means we need to proof that our model is a reusable asset. To demonstrate the applicability of our solution we have derived the original enterprise specific models to demonstrate that not only is a reusable asset but also has each of the three main attributes that guarantees him the reference status: universality (for a certain domain), reusability (for a certain domain) and best-practice. In order to demonstrate
reusability and universality we have calculated reusability and utility ratios respectively in a systematic approach.
To achieve best practice and recommendation character we have tried to involve 3 domain specialists as much as it was possible during whole the construction process until we finally achieved satisfactory acceptance level.

5 Conclusions and Future Work

The results obtained from the validation phase lead us to the following observations:

1. the model is a reusable asset
2. the model is useful but doesn’t provide total universality.
3. the model contains best practices

Considering all the above facts we state that the proposed solution is a reference model for a certain domain. We didn’t achieve total universality but we didn’t expect it either because we don’t feel that every organization specific activity is part of the modeling domain. However this doesn’t mean that all the work is done regarding the model construction. Further improvements must be done to consolidate the existing model and extend the representation domain to other areas of similar interest for the public transportation industry such as clearing house processes or operational management of fleets.

We also conclude that in order to achieve all the main benefits from reference modeling practice a design principle must be applied to guide the reuse process otherwise the return on investment will be lower then expected because the cost of producing such models is bigger that the profit.

Finally we state that if a model can’t be reused it’s not a reference model at all.

6 References


