Modeling, Customer-Specific Configuration and Calculation of Value Bundles

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ABSTRACT

Customers in B2B as well as B2C markets increasingly demand integrated problem solutions from their suppliers, comprising both physical artifacts (products) and services. Applying a mixed-bundling strategy to offer such value bundles to customers foremost requires a sound configuration and economic calculation of value propositions, based on previously defined modules of products and services. In this paper, a modeling language is introduced to describe the function and structure of such modules, as well as to calculate the economic consequences of value propositions on a customer-individual level. The proposed modeling language has been embedded into a software tool to evaluate its utility regarding the customization and offering of integrated value bundles to customers.

KEYWORDS

Value Bundle, Product, Service, Modeling, Configuration, Calculation, Service Science, SSME

INTRODUCTION

According to a service-dominant logic (Vargo and Lusch, 2004, 2007), customers increasingly demand integrated problem solutions that fit their individual needs instead of standardized physical products. One way for suppliers to satisfy this demand is to offer integrated value bundles – consisting of physical products and related services (Hamilton and Koukova, 2007) – as value propositions for customers. Value bundles comprise separately marketable products and services. They can be offered as individual value propositions for customers. If the value proposition is accepted by customers, value bundles are delivered in a service process that needs to be integrated into the customers' processes and therefore requires customer input. Outcomes for customers to be gained from value bundles can have tangible and intangible aspects. By this integration, value bundles are able to create outcomes for customers higher than the summed-up outcomes of their components (see also Schmitz 2008). Already today, offering pure physical products is seldom, as can be comprehended when looking at the services provided in retail. Thus, distinguishing products and services becomes increasingly challenging (Fitzsimmons and Fitzsimmons, 2001; Teboul, 2006; Vargo and Lusch, 2007).

The increasing dominance of the service sector (OECD, 2005) further amplifies the need for suppliers to develop and provide integrated value bundles as problem solutions for their customers. This is especially true for the German Mechanical Engineering and Electrical Engineering industries. Evaluating results from two broad empirical studies in both sectors, Stille comes to the conclusion that turnover related to services has doubled in the Electrical Engineering sector from 9.6% (1997) to 18.5% (2000), while significant gains from 16.8% (1997) to 22.5% (2000) could be identified in the Mechanical Engineering Sector (Stille, 2003). Moreover, Mercer Management Consulting points out, that half of the growth in German Mechanical Engineering in the years 1998-2003 can be accounted to exploiting the potential of services. Likewise, the margin of the service business (10%) is significantly higher than the margin of the product business (2.3%). Furthermore, they state that margins could be even higher when looking at some leading edge services only, which catch margins up to 18% (Mercer 2003). Additional empirical research shows, that companies attribute a high (38.1%) or very high (59.8%) impact on their revenues to their service business. Services are also seen as a good means for differentiation from competitors as well as for customer retention. Consistently, 94.9% of the companies examined plan to grow their business by offering value bundles (Sturm, Bading and Schubert, 2007).

While the necessity to offer services is widely acknowledged, manufacturing companies articulate severe difficulties to systematically describe their service portfolio. Such difficulties seem plausible when considering the apparent lack of modeling approaches for formally describing value bundles (Becker, Beverungen and Knackstedt, 2008). Creating physical products according to formalized specifications has long been in focus of the engineering disciplines and has lead to a considerable degree of standardization. Especially STEP (ISO 10303-41: Fundaments of Product Description and Support; ISO 10303-42: Geometric and Topological Representation; ISO 10303-46: Visual Presentation) has gained particular importance in product engineering (Anderl and Trippner, 2000; ProStep iVip, 2007). Drawing from experiences from product engineering, adapting traditional engineering techniques to the design of services has been discussed under the label Service Engineering since the 1990s (Ganz, 2006), with a focus in governmentally funded service research in Germany. Since then, some modeling languages for engineering services have been proposed (e.g. Corsten and Gössinger, 2003; Klein, 2007; Kunau, Loser and Herrmann, 2005; Luczak, 1991; Shostack, 1977, 1982; Winkelmann and Luczak, 2006; a more exhaustive overview is provided by Becker, Beverungen and Knackstedt, 2008, as well as Emmrich, 2005). However, a consolidation of approaches similar to the standardization efforts in product engineering cannot be ascertained. Hence, modeling of value bundles can be seen as a next step of evolution, integrating approaches from both product and service engineering. Some approaches have recently been proposed (Botta, 2007; Emmrich, 2005; Morelli, 2002; Scheer, Grieble and Klein, 2006), although they did not become evaluated or established in real-life scenarios.

This paper advances the discussion on developing modeling languages for value bundles. Following Alexander's (1970) advice to decompose design problems (in our case designing tailored value bundles) in terms of function on the one hand and economics on the other hand, our modeling languages specifically addresses two major challenges: First, each value bundle offered as a value proposition for a particular customer is contingent on his needs, wants and demands (Arndt, 1978). One option to cope with this variety and reap economies of substitution (Garud and Kumaraswamy, 2003) is to follow a modularization approach by 'assembling' individual value bundles from an array of pre-defined product and service modules. To account for this configuration to take place, a suitable modeling language must be able to represent the possible solution space (consisting of modules, taxonomies and configuration rules) of value bundles for suppliers and customers in an appropriate manner. Second, a suitable modeling language shall support evaluations in terms of economic consequences imposed on suppliers and customers when selecting different configurations of value bundles. Thus, a decision support for selecting an appropriate alternative is conveyed. As the complexity caused by these two challenges requires the modeling language to be implemented into a suitable software tool, we developed a software prototype to provide this functionality.

The remainder of the paper is organized as follows: First, we briefly introduce the specific requirements of modeling value bundles that are addressed in our research design (Section 2). Building on these premises, we show the construction of the modeling language (Section 3) and introduce a first software prototype to support the modeling, configuration and calculation of value bundles (Section 4). We close with a brief summary and show perspectives for further research (Section 5).

REQUIREMENTS FOR THE MODELING OF VALUE BUNDLES

In general, requirements put towards a modeling language originate from the contexts the language will be used in. Due to the broad array of contexts modeling languages for value bundles might be used in – ranging from price calculations to the integration of related business processes in inter-organizational networks – requirements can be quite diverse. A classification of requirements might be accomplished by adhering to the views of service potential, service process, and service result (Hilke, 1989), commonly used in service science. From a (service) potential point of view, a suitable modeling language must support the modeling of resources required to provide services and manufacture products. Additionally, modeling the capacity of these resources is fundamental. From a (service) process point of view, processes to perform service and manufacturing activities are to be represented and integrated with each other to account for the value bundle to be an integrated, customer-specific solution. In this context, one major aspect is to account for the involvement of the customer as a co-creator of value (Vargo and Lusch, 2004, 2007). From a (service) result point of view, the structure of the value bundle and its value proposition for the customer has to be modeled. This includes the representation of taxonomies and configuration rules (e.g. condition, exclusion, substitution).

Additional requirements arise from the intended adoption of a modularization strategy (see previous chapter). To apply this strategy it must be possible to compose value bundles from previously defined modules. This mass-customization approach may allow economies of substitution (Garud and Kumaraswamy, 2003). Benefits include re-using existing knowledge associated with product and service modules, reducing performance slippage when incorporating additional modules into the bundle, reducing incorporation costs for suppliers and customers and – maybe most important – making value bundles modularly upgradeable to cope with changing customer demands (Baldwin and Clark, 1997; Garud and Kumaraswamy, 2003). A prerequisite to assemble bundles from modules are taxonomies (i.e. is-part-of relationships) of modules as well as non-hierarchical relationships (i.e. configuration rules) between modules.

Requirements also originate from the different points of view which suppliers and customers have on value bundles. From the suppliers' point of view, modeling a solution space of consistent (i.e. buildable and desired) configurations is essential. To make the definition of such a solution space possible, product and service modules have to be described adequately and in a formalized notation. Additionally, configuration rules need to be specified to ensure that the customer-specific value bundles to be configured will be consistent. From the customers' point of view, the modeling language must support the derivation of individually tailored value bundles subject to the previously defined generic solution space.

For a sound selection of value bundles, the economic consequences of a decision – for both suppliers and customers – have to be taken into account. For suppliers, it is e.g. crucial to calculate the capital value of different value bundles as well as the capital value of single modules. From the customer's point of view, e.g. original and derivative payments along the entire lifecycle (i.e. total cost of ownership) of the value bundle are of interest.

Figure 1 summarizes and classifies the stated requirements using the categories functional and economic criteria on the one hand and the supplier and customer perspective on the other hand. In the following sections we design and apply a modeling language for value bundles addressing these requirements.

	Supplier's point of view	Customer's point of view
Representation of function and structure	(I) Modeling of possible configurations of value bundles; i.e. modelling of the solution space.	(II) Configuration of customer-specific value bundles; i.e. modeling of instances.
Representation of economic consequences	(III) Calculation of costs related to the acquisition and application of ressources required to provide and combine products and services; i.e. economic consequences for the supplier.	(IV) Calculation of e.g. the total cost of ownership (TCO) related to a specific value bundle; i.e. economic consequences for the customer.

Figure 1: Requirements towards modeling languages for value bundles from a supplier's and customer's point of view.

A MODELING LANGUAGE FOR VALUE BUNDLES

Modeling languages are essential for building models (Schuette, 1998). Generally, a modeling language comprises a conceptual language aspect and a representational aspect (Holten, 2000). The conceptual language aspect (ortho-language) defines the meaning of the modeling constructs and relationships among them. The representational aspect (notation) assigns representation formalisms to these constructs to make them easier to grasp and use for developers and users. The conceptual language aspect of the proposed modeling language is depicted in the Entity Relationship Diagram in Figure 2. The representational language aspect is shown in Figure 3 by presenting some exemplary models.

The starting point for modeling value bundles is the construct *Value Bundle (type)*. It represents the solution space, i.e. all valid configurations of a type of value bundle (e.g. a machine centre with related services) as seen from the supplier's point-of-view (see also the concept of the "generic product model" proposed by Scheer, 2006). It comprises the hierarchical structure (taxonomy) of the bundle, available modules consisting of product and service elements, attributes of atomic product and service elements as well as configuration rules. The Value Bundle (type) construct hence can be regarded as a knowledge base capturing both product and service information and spans the solution space from which customer-specific bundles can be derived.

The static aspect of a value bundle on type level is primarily defined by the modules it is composed of. *Modules* are self-contained units or building blocks containing outcomes (i.e. products or services), which can be re-used in different value bundles. Hence, besides defining bundles from scratch, it is also possible to create models of value bundles (type) by combining existing building blocks, which rapidly speeds up the modeling process. This can be referred to as a mixed-bundling approach (Hamilton and Koukova, 2007).

As already stated, modules are themselves composed of *Outcomes*. Outcomes are the result of some economic factor combination and can be products or services. As the differentiation of products and services becomes increasingly problematic (Sampson and Froehle 2006; Teboul 2006; Vargo and Lusch 2004, 2007), we refrain from making an explicit distinction. Especially in industrial contexts, such as the mechanical or electrical engineering industry, service processes regularly involve physical components, e.g. spare parts, to be used during their execution or vice versa. When modeling with the proposed language, it should be insured, that all outcomes associated with the same module provide a similar value function for the customer. They have to be perceived as more or less interchangeable value propositions that can be selected from by the customer during the configuration process. Hence, outcomes often vary only in terms of their non-functional attributes, such as quality, quantity or price. Outcomes can be arranged in *Outcome Hierarchies*, i.e. outcomes can again be composed of other outcomes. On the one hand, this enables the representation of hierarchical structures as regularly used to describe physical products (e.g. bill of materials). On the other hand, activities found in service processes can be modeled as hierarchical sequences (e.g. maintenance as a sequence of analyze error, resolve error and verify resolution). This hierarchical organization of components is a common means to foster the description and reuse of components (Garud and Kumaraswamy, 2003).

Outcomes are described by *Attributes*. When describing rather physical outcomes, widely used physical (e.g. dimensions), mechanical (e.g. revolutions per minute) or technical (e.g. clock rate) attributes might be applied. As services can be highly intangible and heterogeneous such attributes may not be suitable to describe outcomes which are rather pure services (e.g. consulting services). Instead, functional and non-functional attributes should be used. Functional attributes describe the result of the service process as perceived by the customer. Depending on the type of involvement of the customer during the service process (involvement of the customer himself or herself, involvement of an object of the customer, provision of information; Payne, Storbacka and Frow 2008) functional attributes may vary. Non-functional attributes represent constraints or conditions referring to the provided function. Examples can be as diverse as price, quality, quantity, availability, or delivery and payment conditions (see also O'Sullivan 2006). In addition, references to widely acknowledged standard classifications (e.g. UNSPSC, eCl@ssm or CCG) might be useful to search for, compare and select different outcomes.

To restrict the solution space from which customer-specific value bundles can be derived, to guide the configuration process and to assure consistency the construct *Configuration Rule* is used. The proposed modeling language provides such rules in if-then form. Configuration rules can be used on a module level as well as on an outcome level. If a configuration rule refers to a whole module, an outcome and an attribute have to be specified for the if-part and the then-part respectively. In case a configuration rule refers to a specific outcome, this is unnecessary. In both cases, operators (<, <=, =>, >, =, !=) must be specified to clarify the mode of operation (operators are modeled as attributes of the if-part and the then-part).

As value bundles regularly comprise physical products and related services along their lifecycle, models of value bundles have to account for this dynamic aspect. This is achieved by introducing the constructs *Lifecycle Phase* and *Interval* to model different stages (e.g. pre-sales, operation, and end-of-life) and time periods (e.g. year 1, year 2, year 3) of lifecycles. Both, value bundles and single outcomes can be subject to a lifecycle. For example, in the value bundle "financed, maintained and sustainable machine center" financing services may be provided in the pre-sales phase, the machine centre itself and maintenance services in the operation phase, and recycling services at the end of life. All these outcomes again have a distinct lifecycle; e.g. for the machine center: design, construction, assembly.

Intervals are used to detail lifecycle phases. An interval may comprise several *Activities* to be carried out during its timeframe. As opposed to outcomes, activities are units which are not marketed separately, e.g. particular work-steps. An activity can be carried out by a *Business Unit*, which might be further subdivided into *Jobs*. Moreover, activities comprise operand (the resources to be worked on, e.g. raw materials, additives or supply items) and operant (the resources used to transform the resources to be worked on, e.g. machinery, information and skills) *Resources* (Vargo and Lusch 2004, 2007). By specifying resources and jobs, the potentials needed for offering value propositions to customers can be modeled. For the purpose of economic evaluations, both constructs can be assigned to *Cost Centers*. For convenience, nevertheless it is possible to assign business units and resources directly to intervals, with no need to specify detailed activities.

A last construct, *Customer Resource*, is introduced to account for the integration of the customer as a co-creator of value into service processes. Using this construct it is possible to specify which input (Payne, Storbacka and Frow 2008) the customer has to provide for a service process to be carried out effectively and efficiently. Typical customer resources are information (e.g. problem descriptions), employees (e.g. operating personnel), objects (e.g. a machine to be maintained) or rights (e.g. the right to shut down an assembly line).

During the process of configuring individual value bundle instances, the customer selects outcomes as modeled by the supplier by matching the attributes of outcomes with his or her own preferences. The modeling tool supports this process by presenting the options to be selected from (i.e. modules and outcomes) and by assuring compliance with the underlying configuration rules. The result of the configuration process is represented in the relationship type *Configuration* in Figure 2. The set of these relations for one value bundle on type level defines the configuration of the configured value bundle on instance level. From the customers' point of view, the configured value bundle represents a variant of the generic value bundle described by the supplier.

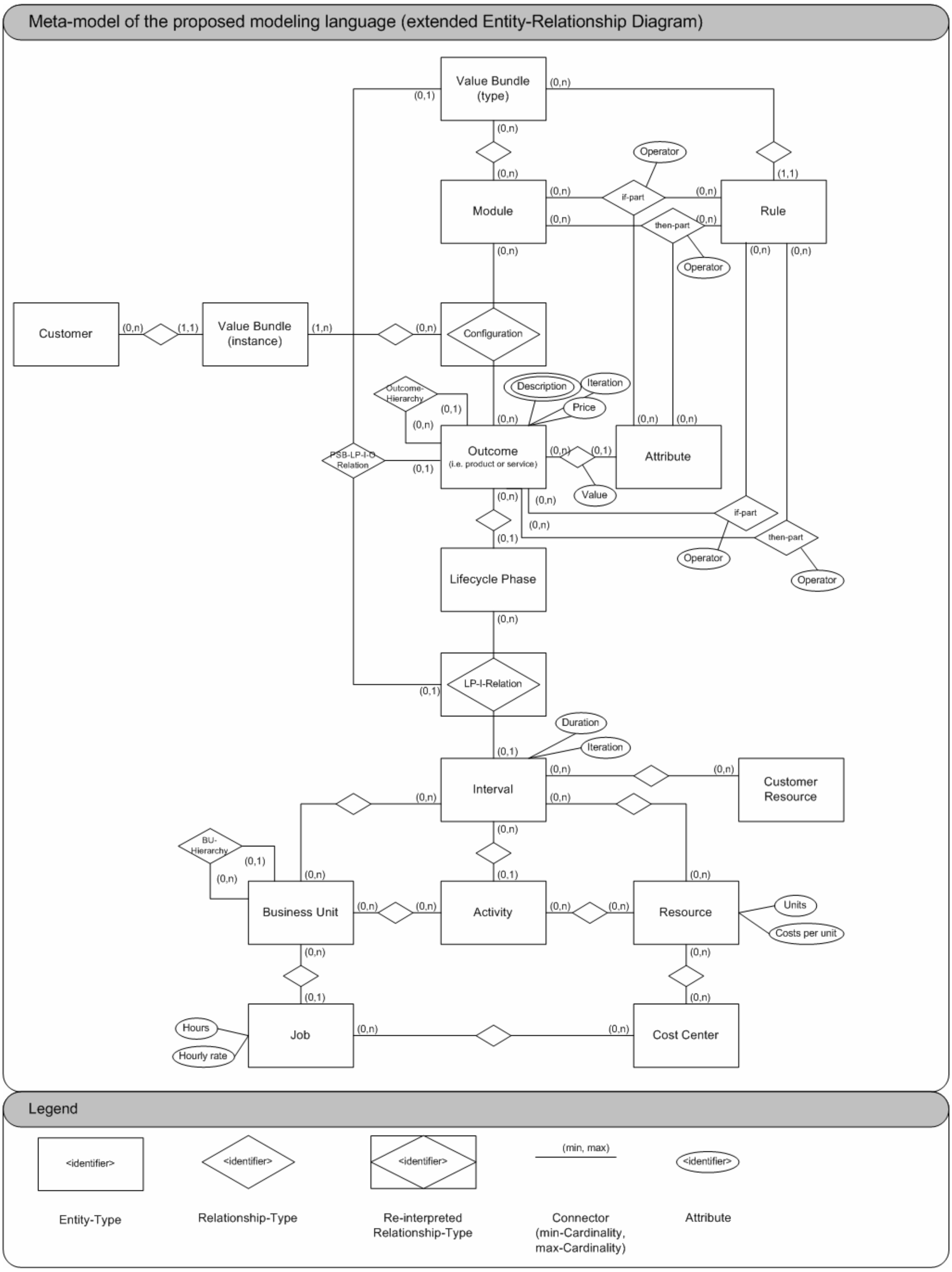

Figure 2: Meta-model of the proposed modeling language.

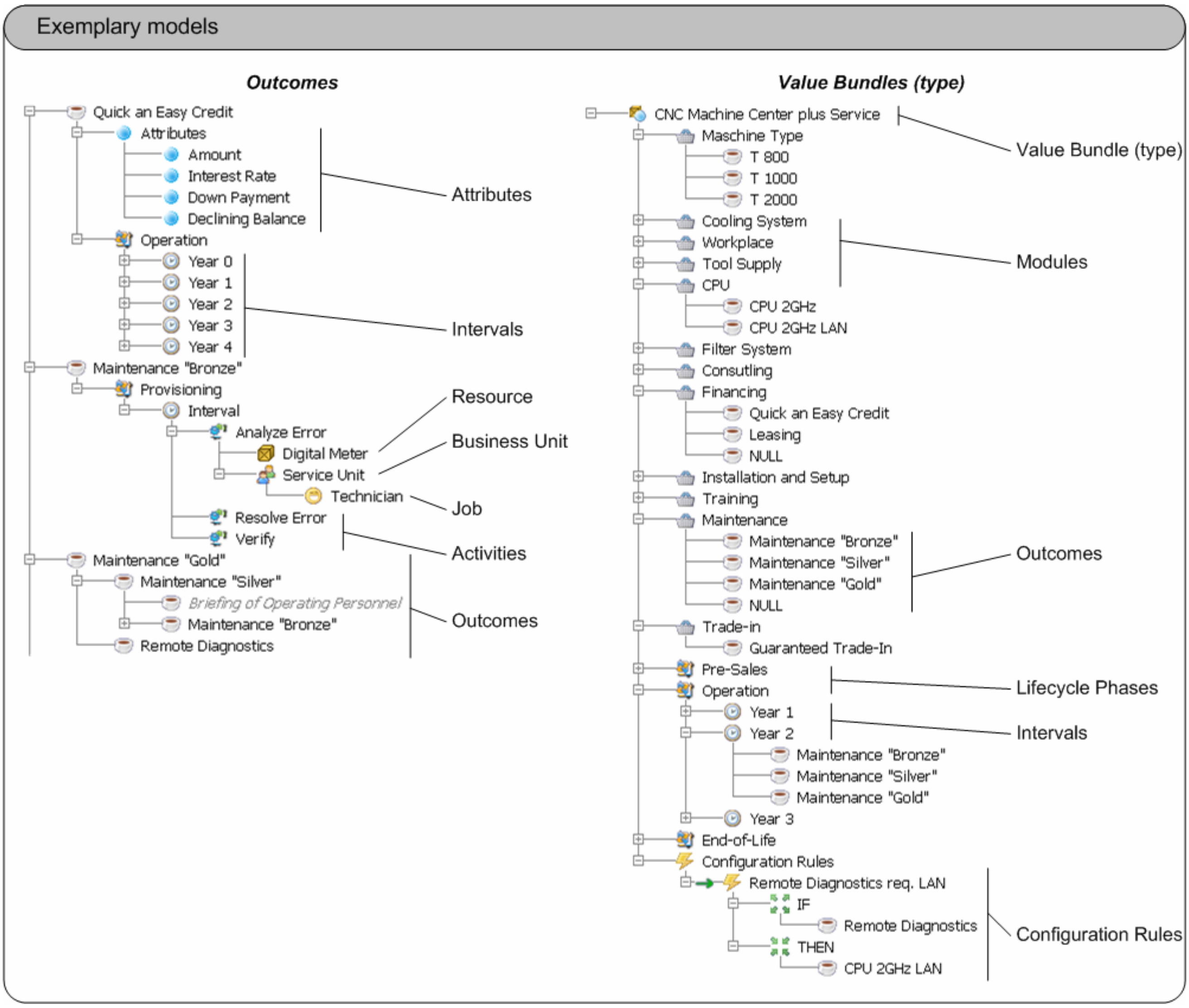

Figure 3: Notation and exemplary models of outcomes and value bundles in the proposed modeling tool.

TOOL-SUPPORT FOR MODELING, CONFIGURING, AND CALCULATING VALUE BUNDLES

In the course of our research project ServPay the presented modeling language has been implemented into a meta-modeling software tool. The client-server architecture of the tool allows for distributed modeling, configuration and calculation of value bundles. It supports the modeling of generic value bundles via standalone-clients as seen from a supplier's point of view, and the configuration of customer-specific value bundle instances as well as the calculation of the economic consequences of selecting a specific value bundle instance via web-clients. Thus, suppliers and customers are provided with decision support on which value bundles to sell or buy, respectively. This overall process of modeling, configuration, and evaluation as supported by the tool is depicted in Figure 4:

1. The supplier models possible configurations of generic value bundles (solution space) that determine which specific variants are generally possible. This is done by composing modules (including outcomes and attributes), configuration rules and lifecycle structures.
2. Customers derive individual value bundles from the solution space (generic value bundle). Usually, customers will not come to a decision straight away, but derive some alternative value bundle instances to make their selection from. The selection process may thus require further (economic) analysis.

3. The derived alternatives can therefore be evaluated with respect to their financial consequences for the customer. Finance plan-oriented methods which allow the explicit modeling of financial alternatives are one method to achieve this (Grob, 1989). On basis of the selected outcomes, their attributes and the lifecycle of the value bundle, the tool compiles the original payments that each selected configuration would impose on the customer.
4. On the basis of these original payments, derivative payments (e.g. tax or cost of capital) are calculated. If the value bundle itself contains financial services, the necessary information (e.g. nominal value, interest, duration) may be directly derived from the value bundle model.
5. To enable a quick overview of advantages and drawbacks related to selecting alternative value bundles, several key figures (most importantly the total cost of ownership (TCO)) can be calculated and compared.

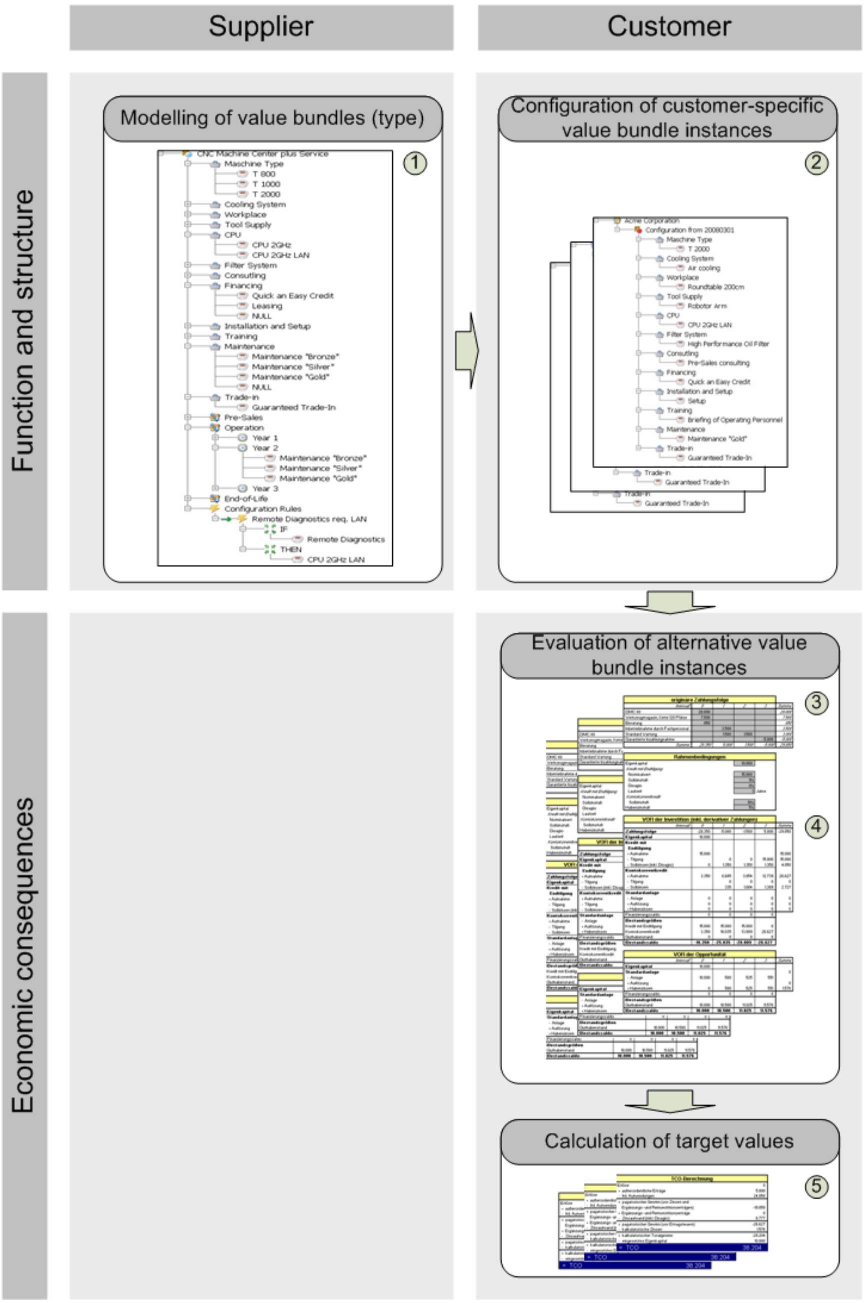

Figure 4: The process of modeling, configuration, and calculation of value bundles (see also vom Brocke, 2006).

As the modeling and configuration have already been addressed in the preceding chapters, the following explanations focus on the calculation of value bundles. Due to the long-running nature of value bundles, their sound selection is comparable with traditional capital investment problems. Therefore, methods used in investment controlling – which also consider long-term economic consequences of decisions – are suitable for an evaluation of value bundles. An investment appraisal typically considers the pay-ins and pay-outs as well as the available equity capital to apply financial calculations (Grob, 1989). From this payment sequence, derivative payments (e.g. cost of capital or tax) can be derived and allow for the computation of the final value of an investment. Beyond that, the total cost of ownership can be calculated if all original and derivative payments along the lifecycle of the value bundle, as well as imputed interest rates for the deployed equity capital are considered. The resulting value can be interpreted as the Total Cost of Ownership (TCO) of the value bundle (Grob and Lahme, 2004; vom Brocke, 2006).

In the following, the steps 3, 4 and 5 as supported by our tool are explained by means of calculating an exemplified use case. ACME Corporation has configured a value bundle consisting of a CNC Machine Centre and an array of related services. The physical items to be capitalized amount to 450,000 EUR for the basic module, 27,500 EUR for the Air Cooling, 5,000 EUR for a Roundtable, 12,500 EUR for a Robot Arm, 1,000 for a CPU, and 2,500 EUR for an Oil Filter; all due in Interval 0. The desired services comprise pre-sales consulting (7,500 EUR) in Interval 0, a credit with bullet repayment (nominal value 300,000 EUR, 9% interest rate, 3 years duration), setting-up the machine by qualified personnel of the supplier (12,000 EUR) and briefing of the operating personnel (2,000 EUR) in Interval 1, maintenance during the operation stage ('maintenance gold', 10,000 EUR in interval 2 and 3), and guaranteed trade-in at the planned end of operation in interval 3 (-200,000 EUR). The planned lifecycle of the value package comprises 3 years in total.

From these financial data which can be derived from the lifecycle information and outcome attributes of the value bundle model, the tool is able to calculate the original payment sequence of the value bundle selected by ACME Corp (see exemplary data flows in Figure 5). Furthermore, the majority of financial parameters of the investment can be derived from the selected service 'Quick and Easy Credit'. Only information, which differ from customer to customer, such as available equity capital and the interest rate of the open account credit have to be specified by ACME Corp. during the process of calculating the value bundle.

On the basis on the original payment sequence and these financial parameters, the derivative payments for the planned investment can be calculated. To achieve this, all payments in each interval are calculated against the background of the financial parameters, like equity capital, fixed credits and open account credits. Additionally, debit interests and financial investments are calculated.

Finally, the imputed interests applying to the equity capital that has to be expended to finance the investment have to be computed in a separate financial plan. Based on the compiled data, the TCO for the selected value bundle can now be determined (see bottom of Figure 5). In addition to the payment sequence, interest rates, imputed interest, and the equity capital to be expended are taken into account. This calculation can be carried out respectively for alternative configurations of the value bundle. Consecutively, the TCO values to be derived from these analyses can be compared to finally select the most adequate value bundle from an economic point of view.

CONCLUSION AND OUTLOOK

In this paper, we showed that a modeling language for value bundles must account for several requirements. These requirements were systematized in four quadrants, subject to functional and economic issues, as well as subject to the suppliers' and customers' point of view. First, the structure of the value bundles to be offered has to be specified by the supplier. Therefore, the supplier defines the modules to be offered along with configuration rules and a lifecycle model (quadrant 1). These restrictions are used to limit any configurations to be made by customers while deriving individual value bundle instances form the solution space. (quadrant 2). The modeling language and the tool support proposed in this paper show, that this concept can be applied to value bundles to be offered as value propositions to customers in a service economy. The evaluation of the concept in real-life scenarios will be performed in consecutive steps of our research projects.

From an economic perspective, the computation of the Total Cost of Ownership for specific configurations of value bundle instances from a customer's point of view has been demonstrated (quadrant 4). In real-life transactions, customers increasingly demand TCO information from their suppliers. In further research steps we will ascertain, whether and to what extend suppliers might want to give away this information.

The calculation of economic consequences of delivering value bundles (i.e. costs related to the acquisition and application of operand and operant resources – quadrant 3) is only partially addressed by the current release of our tool. Compared to the other quadrants, this issue requires the most exhaustive extensions to be made.

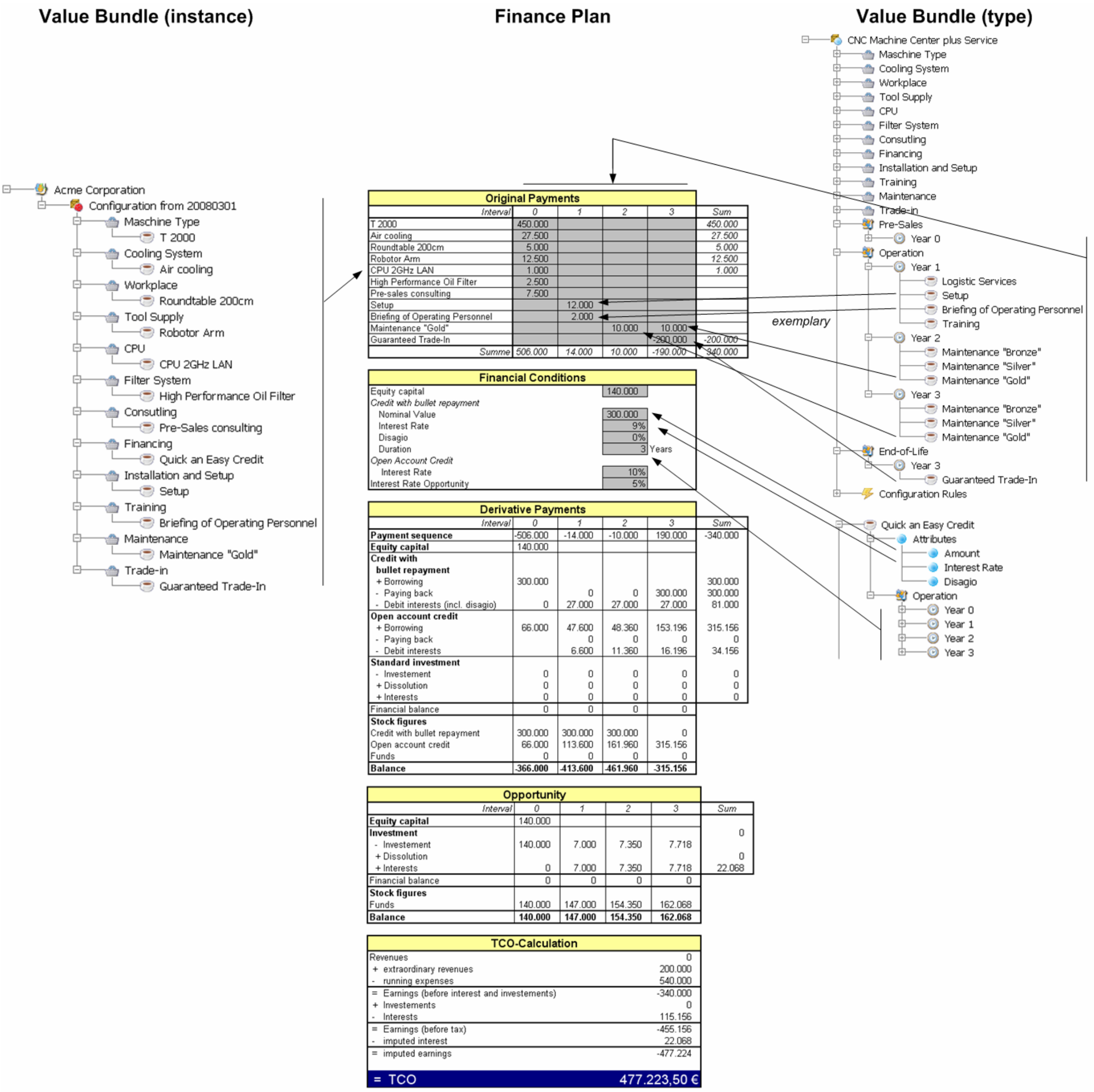

Figure 5: Exemplified calculation of the TCO for an individual value bundle instance.

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