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Sähkö- ja tietoliikennetekniikan osasto

Tekijän nimi	Mikko Heiskala
Diplomityön nimi	A Conceptual Model for Modeling Configurable Services from a Customer Perspective

Diplomityö, joka on jätetty opinnäytteenä tarkastettavaksi
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Mass customization aims to provide customized products on a large scale at near mass production efficiency. One way to implement it is through configurable products that comprise numerous product individuals in a one common design. A configuration model describes the product individuals than can de produced. Product configurator is an information system that supports the specification of product individuals and the creation of configuration models. Configuration models are defined in a configurator using a modeling language that is built on a conceptual model of knowledge on configurable products.

Mass customization and product configuration of services has received relatively little attention in literature. It is widely recognized in service literature that goods and services are conceptually different. Due to this difference the current configuration conceptual models may not be optimal for configuration of services.

This thesis examined what kind of a conceptual model would be suitable to model configurable services from a sales configuration and customer perspective.

The research was carried out using a constructive method. The relevance of the research problem was established with the above-mentioned literature gap and increased demand for customized services. After obtaining an understanding of the subject through a broad literature research spanning mass customization, configurable products, services, and relevant modeling approaches the conceptual model was developed. It was evaluated by successfully modeling an example that is loosely based on real insurance services.

The developed conceptual model consists of four worlds: one intended to capture the service recipient (often the customer) characteristics, another for describing customer needs, third for describing the service agreements, and fourth for capturing the service delivery process and customers' role in it. The model uses mostly the same variability modeling mechanisms as the existing configuration conceptualizations.

The conceptual model appears to support the modeling of configurable services from a sales and customer perspective. The model extends and simplifies the prior modeling approaches. None of the studied prior models provide concepts specifically intended to capture the service recipient characteristics. The model extends the existing configuration conceptualizations with mechanisms for process modeling. However, the evaluation of the model is limited to domain of insurance services and cannot be considered extensive.

Keywords: configuration, services, conceptual model, mass customization, configurable services

TEKNILLINEN KORKEAKOULU Diplomityön tiivistelmä

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Työn nimi: Käsitemalli konfiguroitavien palveluiden mallittamiseen asiakasnäkökulmasta

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Massaräätälöinnin tavoitteena on tuottaa asiakkaiden yksilöllisiin tarpeisiin räätälöityjä tuotteita suurissa määrin lähes massatuotannon tehokkuudella. Yksi tapa massaräätälöintiin ovat konfiguroitavat tuotteet. Konfiguroitavan tuotteen kaikki mahdolliset tuoteyksilöt kuvataan yhdessä suunnitelmamallissa. Konfigurointimalli kuvaa kaikki tuotettavissa olevat tuoteyksilöt. Konfiguraattori on tietojärjestelmä, joka tukee tuoteyksilöiden määrittelyä ja varmistaa ja konfigurointimallien luontia. Konfigurointimalli määritellään konfiguraattorissa käyttäen konfigurointimallituskieltä, joka perustuu käsitemalliin tietämyksestä konfiguroitavista tuotteista.

Palveluiden massaräätälöintiä sekä konfigurointia on tutkittu suhteellisen vähän. Palvelukirjallisuudessa palveluiden ja tavaroiden käsitteellinen eroavaisuus on varsin laajasti tunnustettua. Tästä erosta johtuen nykyiset konfigurointikäsitemallit eivät välttämättä ole optimaalisia palveluille.

Tämä työ tutki sitä, millainen konfigurointikäsitemalli sopisi palveluiden mallittamiseen myyntikonfigurointia varten asiakkaan näkökulmaa käyttäen.

Tutkimus noudatti konstruktiivista menetelmää. Tutkimusongelman tärkeys motivoitiin yllämainitulla aukolla kirjallisuudessa sekä räätälöityjen palveluiden kysynnän kasvulla. Ymmärrys aiheesta hankittiin laajalla kirjallisuuskatsauksella, joka käsitteli massaräätälöintiä, konfiguroitavia tuotteita, palveluita ja oleellisia mallitustapoja. Käsitemalli kehitettiin ymmärryksen pohjalta. Sitä arvioitiin mallittamalla onnistuneesti oikeisiin vakuutuksiin löyhästi perustuva esimerkkipalvelu.

Käsitemalli sisältää neljä maailmaa. Yksi maailma kuvaa palvelun vastaanottajan (usein asiakas) piirteet. Toinen kuvaa asiakkaan tarpeet ja kolmas palvelusopimukset. Neljäs kuvaa palvelun toimitusprosessin ja asiakkaiden roolin siinä. Käsitemalli käyttää enimmäkseen samoja mallittamismenetelmiä kuin nykyiset konfigurointikäsitemallit.

Käsitemalli vaikuttaa tukevan konfiguroitavien palveluiden mallittamista myyntikonfiguroinnin ja asiakkaan näkökulmista. Malli sekä laajentaa että yksinkertaistaa aiempia mallitustapoja. Yksikään työssä tutkituista malleista ei määrittele käsitteitä, jotka olisi erityisesti tarkoitettu palveluiden vastaanottajien piirteiden mallittamiseen. Käsitemalli käyttää samoja varioituvuuden mallittamismekanismeja kuin nykyiset konfigurointikäsitemallit sekä laajentaa niitä käsitteillä prosessien mallittamiseen. Mallin arviointi rajoittuu kuitenkin vain vakuutuksiin, eikä sitä voida pitää kattavana.

Avainsanat: konfigurointi, palvelut, käsitemalli, massaräätälöinti, konfiguroitavat palvelut

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Docent Timo Soininen's insightful comments have greatly improved the scientific quality of this thesis. Juha Tiihonen's help has been invaluable, especially when honing the main contribution of this thesis, the conceptual model. I wish to thank Kaija-Stiina Paloheimo and Andreas Anderson and all the other colleagues I have been privileged to work with both at SoberIT and BIT Research Centre during ConSerWe. You have been good sparring partners for my thoughts about the model.

Finally, I want to thank my parents for the support and encouragement you have always given me. I could not have wished for better parents.

Espoo, June 2005

Mikko Heiskala

1 INTRODUCTION

1.1 BACKGROUND AND MOTIVATION

Service has been defined as a process taking place in interactions between the customer and service employees, which is provided as a solution to customer problems (Grönroos 200, pp. 46). Today, services are an important part of the economy (Grönroos 2000; Fitzsimmons & Fitzsimmons 2004). Furthermore, an increasing number of companies whose main business is selling goods are integrating services into their offerings (Wise & Baumgartner 1999). However, the service industry is facing tough challenges. Fierce competition is eroding margins and driving commoditization of service offerings, which makes it tougher for service companies to differentiate. Their customers are fragmenting to smaller niches and are demanding services that meet their increasingly diverse needs better (Harvey et al. 1997; Akkermans et al. 2003; Papathanassiou 2004). Additionally, customers want their services delivered when and where they want them (Harvey et al. 1997) through a variety of different channels (Lee 2002).

Some researchers suggest that service companies should meet these problems by structuring their services and operations to match different customer needs (Anderson & Narus 1995; Bettencourt & Gwinner 1996; McLaughlin 1996; Harvey et al. 1997; Buzacott 2000). For some time, many goods manufacturers have tackled the problem of meeting diverse customer needs with a strategy of *mass customization* (Pine 1993a, 1993b; Kotha 1996; Berman 2002; Forza & Salvador 2002a; 2002b; MacCarthy et al. 2003). Mass customization is the ability of a company to provide products tailored to individual customers needs on a large scale with efficiency comparable to mass production (Pine 1993a, 1993b; Hart 1995; Zipkin 2001; Da Silveira et al. 2001). The financial services sector is warming up to mass customization too (Papathanassiou 2004).

One way to aid implementation of mass customization is to develop *configurable products*, which in one common design comprise numerous *product variants*, each meeting different customer needs. All possible product variants are described in a *configuration model*. A *configurator* is an information system that supports configuration model creation and repetitive specification of product variants, called *configuration task*, making it relatively routine (Sabin & Weigel 1998; Kruse & Bramham 2003; Tiihonen et al. 2003). In configurators, a configuration model is usually defined using a *configuration modeling language*.

A configuration modeling language is a formal language built on a *conceptualization* of knowledge on configurable products, see Figure 1. A conceptualization, or *conceptual model*, is a mental image of an area of interest that consists of the main concepts and their relationships.

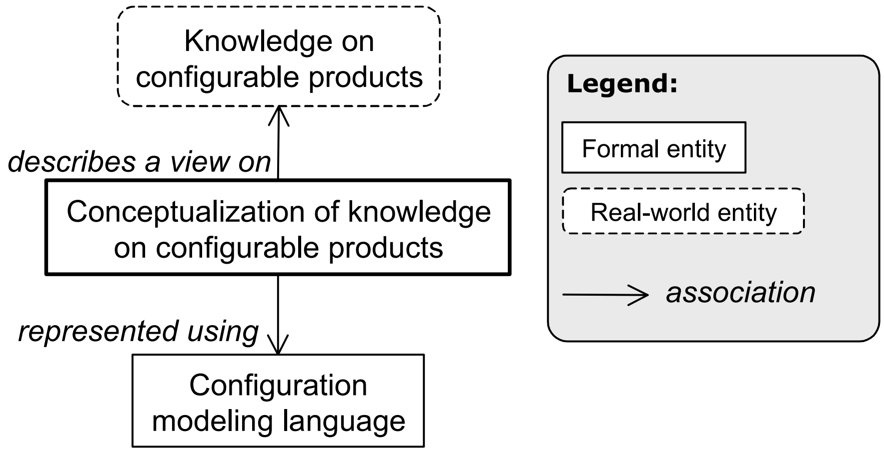

Figure 1 Roles in representing knowledge on configurable products, adapted from (Soininen 2000)

There is evidence that manufacturing companies employing a configurator have been able to deliver configurable products more efficiently to their customers (Tiihonen & Soininen 1997; Forza & Salvador 2002a; 2002b). Same improvements could be achieved in delivering customized services or *configurable services* also. For the purposes of this thesis the following definition is adopted: configurable services are services that can be customized to individual specifications from a set of options designed to meet a pre-determined range of customer needs. However, to achieve the same improvements with configurators in services as in manufacturing, a suitable conceptualization for modeling services in a similar way as configurable products is needed. Such a conceptualization has to be defined formally enough to serve as a basis for a configuration modeling language in a configurator. In (Papathanassiou 2004), the development of IT tools that support decision-making on the Internet, give an organization and its customers an opportunity to change features of a service, and help customers to choose the right service, are called for to support mass customization in the financial services industry. All are issues that product configurators can support.

There seems to be relatively little literature on configurable services. How to achieve and manage service customization in general is a relatively understudied field (Bettencourt &

Gwinner 1996; McLaughlin 1996; Harvey et al. 1997). Also, Da Silveira et al. (2001) state in their review of mass customization literature that the current literature lacks studies of mass customization in service operations. Duray et al. (2000) call for future research of services in mass customization settings too. Ramdas (2003) suggests in his literature review on product variety that variety management in services is a field that has received little attention and needs more future research. Furthermore, research on configurable products seems to be mainly focused on goods too, and lacks empirical examples from the service domain. Interestingly, Grönroos (2000, pp. 52) and Johns (1999) see the customization of goods having service characteristics, being a kind of service in itself. The service literature might offer valuable insights to goods customization.

On the other hand, the literature on customized goods is not that sparse. Yet, applying the research results from customization and configuration of goods to services might not produce optimal results for two reasons. First, the differences between goods and services, and the operations related to their production are widely recognized (Bowen et al. 1989; Silvestro et al. 1992; Jackson et al. 1995; Grönroos 2000; Bowen & Ford 2002). Given the relatively different nature of goods and services, the extent to which the results from another domain are applicable in the other should be at least questioned, a point highlighted by Da Silveira et al. (2001) and Peters & Saidin (2000) also. Further, Wimmer et al. (2003) argue for the same reasons that simple adoption of modeling approaches from material goods is not possible. However, that is not to say that nothing can be learnt from goods customization. The differences must be considered when attempting to apply the research on goods to services. Second, the utility and quality of conceptual models, i.e. conceptualizations, should be evaluated in the domain of their intended use (Lindland et al. 1994; Gemino & Wand 2003; Shanks et al. 2003). The apparent lack of empirical evidence of applying configuration conceptualizations to model services lessens the confidence in their feasibility in the service domain.

1.2 Research Problem and Goals

This section lays out the research problem and the research objectives.

The research problem of this is the following:

> *What kind of a configuration conceptual model can be used to model services from a customer perspective?*

The thesis aims to shed light on the problem by meeting the ensuing goals:

First, in order to answer this question, there is a need to study:

- Mass customization of goods and the role of configurators in it.
- Services in general and especially how goods and services differ. This is necessary in order to know what can be applied from goods to services and if there are any services specific issues.
- The conceptualizations used for configurable products.
- The existing, preferably formalized, service modeling conceptualizations having a customization and/or configuration perspective, if any exist.
- Possible other conceptualizations that are used to model products or services from a customer perspective.
- The characteristics of customized services in case companies.

Based on the gained understanding, the goal is to:

- Define a conceptual model for modeling configurable services from a customer perspective either by developing a new one or by refining, extending, or synthesizing existing conceptualizations.

The quality of the conceptualization, or in other words the conceptual model, should be evaluated from three viewpoints:

- The purpose of the conceptualization is to enable selling services with a configurator used either by customers themselves or sales personnel or the two in co-operation, possibly over the web. In other words, the conceptualization should support the elicitation of customer needs so that customers can buy a service meeting their specific needs or help sales personnel in selling such a one to a customer.
- The conceptualization should fit the service domain. To be more explicit, it should represent the service domain with all relevant concepts needed to model

configurable services, specifically from a customer perspective. Moreover, the conceptualization should be readily understandable, for both modelers and configurator users alike, and it should guide modelers to create models of good quality. Or like Lindland et al. (1994) put it, a conceptualization should be appropriate for the domain (extent of statements needed in the domain) and its audience (extent to which the audience is able to learn, understand, and use the conceptualization).

- The conceptualization should correspond to criteria independent of its intended purpose and domain of use. It should be unambiguous, i.e. each concept should have only one interpretation, and concise, meaning that it should contain only the concepts that are necessary. The conceptualization should also be precise enough to serve as a basis for software implementation.

1.3 Research Method

This section gives first in 1.3.1 the relevant background for the research methods used in this study and then describes in more detail how they were applied in the study in 1.3.2.

1.3.1 Method Background

This chapter gives background information on the research methods that were applied in this study.

Shaw has discussed (2001) and studied (2002; 2003) what constitutes good research in software engineering field. Shaw proposes that a good research paper communicates to an interested reader *what was accomplished*, *how it was accomplished*, and *why should the reader care*. In (2003) Shaw lists a number of questions, which when properly answered, should help to communicate these issues, i.e. the research *question*, *result*, and, *evaluation* method (Shaw uses validation).

- What, precisely, was your contribution? *Answered by explaining the problem you set out to solve and the larger question it addresses – and why it is important.*

- What is your new result? *Answered by describing your solution precisely and in detail and then explaining how it improves the store of current knowledge and how it is useful beyond your own research setting.*

- Why should the reader believe your result? *Answered by showing evidence that the result is valid – that it actually helps to solve the problem you set out to solve.*

The *constructive research approach* (Kasanen et al. 1991; 1993) is a research procedure for producing *constructions* i.e. solutions to explicit practical problems that can be implemented. The main elements of constructive research are shown in Figure 2. The construction should be a solution to a practically relevant problem and its connection to the prior theory made explicit. Furthermore, the practical utility of the solution has to be tested and analyzed along with the theoretical contributions of the construction and the accompanying study.

Figure 2 The main elements of constructive research (adapted from Lukka, Metodix.com)

The typical process of constructive research can be seen in Figure 3. In the first step, *a practically relevant problem is found that has theoretical interest* also. For example, a problem may be interesting theoretically because it is has not been researched enough in the previous literature. Next, a *deep and comprehensive practical and theoretical understanding of the topic is obtained.* In the third step, a *problem solution is developed*, followed by its actual *implementation and testing* in the fourth step. Next, the *scope of applicability of the solution is examined.* Could the construction be used in other domains? Finally, the *theoretical contributions are identified, analyzed, and reported* as such and with relation to prior literature.

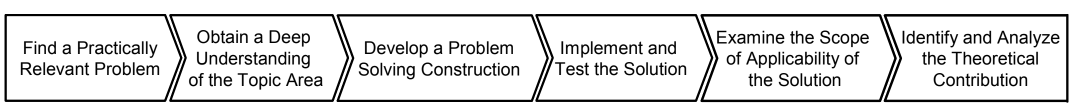

Figure 3 The process of constructive research (adapted from Lukka, Metodix.com)

When one compares the elements of the constructive research approach and its typical process to the issues and questions listed by Shaw, the similarities can hardly be missed. This thesis aims to solve a practical problem by developing a conceptual model. The model can be seen as a construction. Therefore, it seems appropriate to use the constructive research approach as the basis of the research method in this thesis.

Shaw (2001; 2002; 2003) also discusses what kinds of research questions yield certain types of research results, and how these results should be evaluated. Shaw (2002; 2003) suggests that conceptual models should be evaluated by showing examples of how they worked on a certain problem, by giving examples of their usage in real problems by someone else than the author, and by showing evidence of their actual usefulness and effectiveness on those problems.

Frank (1998; 1999) has discussed how conceptual models and modeling languages should be evaluated. Frank states that often only modeling language designers alone decide the relevance of language features and that the evaluation is left to evolution i.e. the approach that dominates in the end is the most suitable, in his terms "best practice". According to Frank, these are not satisfactory criteria for scientific research. First, the quality of a conceptual model depends on multiple factors like the very purpose of the model, its potential users and their perceptions, which may vary over time, some of which may be out the scope of language designers. Second, if the evaluation is left only to the best practice it does not allow beforehand evaluation, which is desirable if realizations of designs are not to be created just to test them. Frank adds that leaving the evaluation to markets with the best practice prevents comparisons focusing on modeling language quality only. (In the time scope of this thesis the best practice approach is hardly a possible option to evaluate the resulting model anyway.) Frank (1998) admits that modeling languages can be evaluated on formal and expressive aspects that are often very important for the quality of a language as it often should provide a basis for implementation of correct and reliable software. Such formal aspects can be e.g. completeness, simplicity, correctness and the expressive power of the language. However, he points out that the formal and expressive aspects alone do not allow discriminating between languages of equal quality on those aspects. In addition, the formal and expressive aspects entirely neglect both the purpose of the model and the users' perceptions. However, Frank (1998; 1999) states that even if it may be impossible to give an objective judgement over the quality of conceptual models there still can be useful evaluation. Frank proposes that the evaluation should take into consideration multiple perspectives, the more the better.

1.3.2 METHOD DESCRIPTION

This chapter describes how the research was carried out in the study. This study followed the overall process of constructive research, see Figure 3, as does this chapter also. An overview of much of the ensuing discussion in this chapter can be found in the thesis research roadmap shown in Figure 5.

The previous chapters have striven to convince the reader of both *the practical and theoretical relevance of the research problem*. Much of the previously presented material is based on the parts of the literature review that concentrated on finding issues touching the relevance of the research problem.

The goal of the rest of the literature review was to *obtain a deep understanding of the problem domain*. The review was supported in this by research material gathered and analyzed in the ConSerWe[1] project's case companies by the author and other researchers. For the cases presented in this thesis, case data were gathered through document analysis of contract, operational, marketing, and market research material, through 15 semi-structured interviews of managerial level supplier company employees, and through four workshops and a number of company visits. For the Tapiola case, additional data were obtained from three mystery-shopper visits, which are used in marketing for e.g. service evaluation. Additional data for the maintenance case were obtained through 10 semi-structured customer interviews, through observing a service sales training event and the work of a maintenance engineer.

The framework used to structure the literature review and case company information is presented in Figure 4. The first aim was to understand mass customization and how product configuration supports it. The second aim was to study the nature of services, the service operations, and how services are customized, the point-of-view being to find out the relevant *differences and similarities between goods and services*, and their operations in a (mass) customization setting. Detailed attention was given for product configuration and especially for the conceptualizations used to model configurable products. These were compared to the different modeling approaches for services with potential to describe configuration aspects.

[1] This thesis was written as part of ConSerWe (Configurable Services on the Web) project. http://www.soberit.hut.fi/ConSerWe/

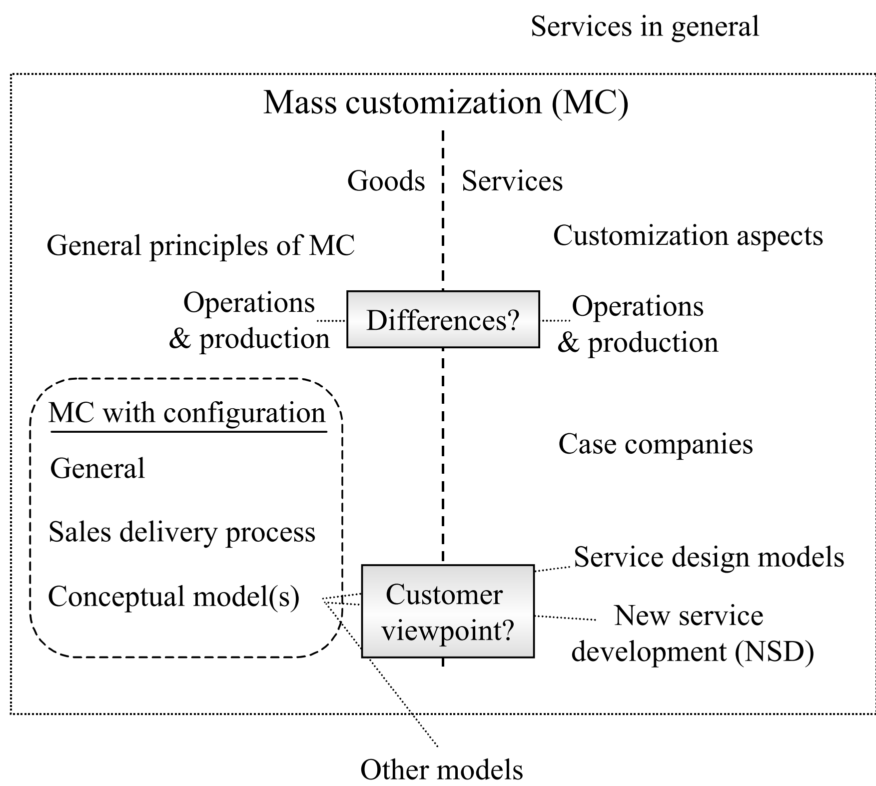

Figure 4 Framework for literature review and case studies

After the literature review, the lessons learned thereof were applied to *developing a construction to solve the research problem*. First, the conceptual model was implemented, based on the literature research results and case company experiences. Next, the conceptual model was *tested* by modeling real services of the case company Tapiola Group. The *scope of applicability* of the model was analyzed in general and in relation to the feedback received from the maintenance case companies. The strength of confidence the applied evaluation methods give to the research results was also touched upon. The *theoretic contribution* of the study was then first *identified* by describing the research results in detail, and then *analyzed* in relation to prior research.

1.4 SCOPE

This section elaborates the decisions made when limiting the scope of the thesis and the confines of the literature study and evaluation methods.

The literature review was done using the scientific databases available from the Library of the Helsinki University of Technology. Databases used were ABI Inform, ACM Digital

Library, CiteSeer, EBSCOHost, Emerald Library MCB, IEEE/IEE Electronic Library, JSTOR, Kluwer Online, ScienceDirect, and SpringerLink. The literature review on mass customization, product configuration, and services was on the level of journals available through these databases (and some major books). The search terms included the following: mass customization, services, customization, product configuration, configurable products, configurator, configurable services, conceptual model, conceptualization, and modeling. For product configuration, material from previous Configuration Workshops and special issues on configuration in journals related to artificial intelligence was used as well.

The service literature was studied to understand services first in general, and then focusing on the differences and similarities between goods and services. The new service development and service design literature was studied particularly to find out how services are modeled for design purposes. The product configuration conceptualization of Soininen et al. (1998) and Felfernig et al. (2000) were chosen for closer examination. The choice was done to limit the scope to a manageable size for a master's thesis. Further, the two conceptualizations synthesize and extend the main existing configuration approaches being thus arguably representative of other configuration conceptualizations. Besides the general service literature, searches were made to find out conceptualizations that could grasp both the configuration and customer view aspects of services. For these, the study had to resort to the Internet also due to the sparsity of literature on a journal level. General process modeling literature was not studied due to its vast numbers. The process modeling approaches in the service-oriented modeling approaches were considered sufficient.

Other companies than the Tapiola Group insurance case were not used for configuration modeling evaluation to limit the scope to a manageable size for a master's thesis.

1.5 Outline

The structure of thesis is as follows. Chapters 2, 3, and 4 provide the background for the thesis. The chapters discuss mass customization, product configuration, and services. The core of the literature research of the thesis is presented in chapter 5 that presents the studied modeling approaches. The case companies are described in chapter 6. The next chapter rounds up the requirements for the conceptualization on basis of the literature and case company findings. The developed conceptual model is then presented in chapter 8 and its evaluation in chapter 9. The model is discussed in chapter 10 and conclusions end the thesis with chapter 11.

The process of constructive research	Find a Practically Relevant Problem	Obtain a Deep Understanding of the Topic Area	Develop a Problem Solving Construction	Implement and Test the Solution	Examine the Scope of Applicability of the Solution	Identify and Analyze the Theoretical Contribution
The process steps applied in this thesis	Study the current literature for… •practical motivation for service customization •signs of lack of relevant literature to show the theoretic interest	Read on… •mass customization •goods vs. services •service operations •product configuration •service design, new service development •other models Study ConSerWe case companies	Based on topic understanding… •define the conceptual model	•Use the conceptualization to model the case company services	Discuss… •if the model can be used in other than case company service domains, its generalizability •strength and scope of evaluation •willingness in companies to use the model	Describe… •the model •its relation to the prior research, especially gaps in it Define the potential improvements… •in the evaluation methods •compared to the prior models
Objectives addressed in the phase, partially following Shaw (2001; 2002; 2003)	Define the research problem. Find evidence of research problem importance, both practical and theoretic. Describing where it fits in the big picture.	Gaining a theoretic and practical understanding of the domain to develop the model. Finding out if an existing conceptualization can be refined/ extended or need a new one.	Identify the requirements for the model. Defining the conceptual model. Describing it in detail.	Using appropriate empirical evaluation methods.	Finding opportunities and limitations to use the model outside the evaluation domain.	Explaining… •The motivation for a model geared towards services, why old ones not enough. •the empirical results from evaluation •any improvements to prior art •the limitations of the model •avenues for future work
Chapters of the thesis where issues are discussed	1.1; 1.2	Mass customisation: 2; configuration: 3; services: 4; other models, 5; cases: 6	Requirements: 7; model description, 8	Case example: 8	Evaluation: 9	Motivation: 1.1; 1.2, evaluation: 9; prior art: 10.2, future work: 10.3, limitations: 10.4

Figure 5 Thesis research roadmap

2 MASS CUSTOMIZATION

This chapter first gives a more detailed overview of mass customization than what was given in the Introduction. It is followed by a discussion of mass customization implementation in 2.2, requirements for a successful MC implementation in 2.3. The chapter concludes be contemplating the benefits that can be gained from mass customization, and challenges there can be in adopting it in 2.4.

2.1 OVERVIEW

Mass customization (MC) can be defined as a strategy of providing even individually customized goods or services at production costs and lead-times of, or close to, large-scale mass production (Pine 1993a; Da Silveira et al. 2001). Hart (1995) gives a more broad, and in his words a visionary and idealistic definition for MC: "the ability to provide your customers with anything they want profitably, any time they want it, anywhere they want it, any way they want it". In reality, the profitability requirement of the above definition compromises the other goals or at least restricts them to a "pre-determined envelope of variety" (Hart 1995). To put it differently, the customer is given a range of options on what can be delivered, when, where, and how.

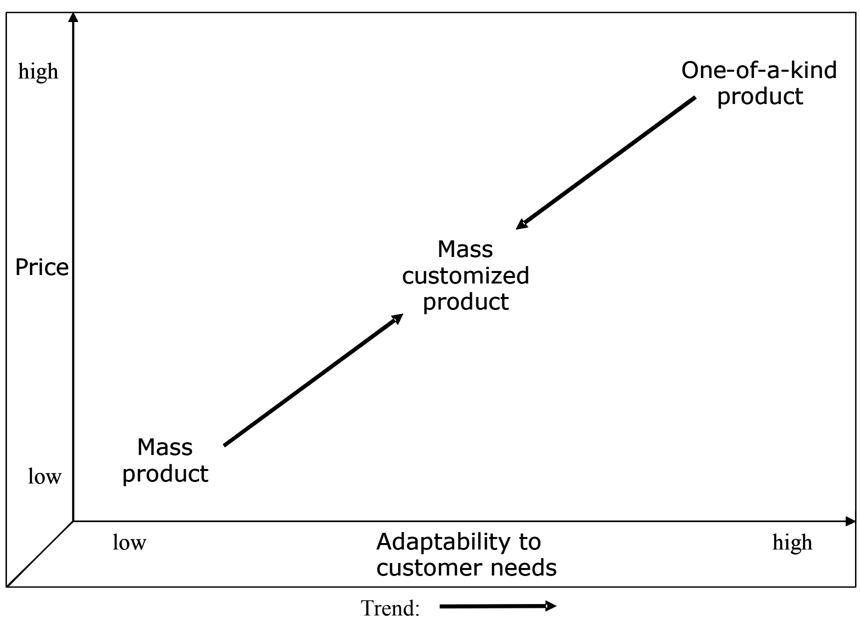

Figure 6 Convergence towards mass customization, adapted from (Tiihonen & Soininen 1997 and Svensson & Barfod 2002)

There is a trend of companies converging towards MC from mass production and one-of-a-kind products (Tiihonen & Soininen 1997; Tiihonen 1999; Svensson & Barfod 2002; Lampel & Mintzberg 1996), see Figure 6. MC tries to combine the benefits of both crafted (or one-of-a-kind) and mass-produced products, that is products meeting individual customer needs better of crafted production and doing that effectively with relatively low prices and costs, as in mass production.

2.2 MASS CUSTOMIZATION IMPLEMENTATION

This section briefly describes how MC can be implemented and what kind of capabilities a company may need to do it.

Zipkin (2001) states that to successfully operate with MC the company should have three key capabilities in place: *elicitation, process flexibility,* and *logistics* capabilities. Naturally, the products have to be customizable (Da Silveira et al. 2001). The following is based on Zipkin (2001) and Berman (2002) who discusses Zipkin's ideas also.

Elicitation is a mechanism of interacting with the customer to learn about customer specific information and their needs. Learning about needs is difficult. Often customers don't know what they really want or are unsure about it. Even if they do know what they want they often cannot communicate it accurately. Moreover, what customers want may not be what they actually need. Information about the customer can be significant for MC too. For example, exact body measurements are necessary for custom-made clothing. To put it bluntly, *you can't give customers what they want without learning what that is first*.

A high-volume but flexible process is needed in MC to translate the customer specific information into the actual product. How difficult it is to achieve sufficient process flexibility and keep costs comparable to mass scale processes, depends on the products fabricated. For example, processing information (like personalized news in Internet) is more flexible than processing physical parts (like in car manufacturing). Often only some stages of the overall process can be made flexible. For example, Levi Strauss doesn't offer custom colors because fabric dyeing can't be done on a large scale (Zipkin 2001). In short, if you want to give customers what they want your production process must be able to adapt to customer specific products.

The logistics steps into play after (and partly during) the product is fabricated. To be able to deliver the product to the right customer at least information about the customer's identity must move along with the product. This must happen during product fabrication. In contrast to mass production, in MC the company must able to ship a correct product directly to the customer.

There is an underlying thought in Zipkin's (2001) and Berman's (2002) discussion: there are three phases in MC process that a company generally must go through when delivering a customized product for a customer. The phases and the MC capabilities needed in them are collated and illustrated in Figure 7.

MC process phase	Specifying the product customer wants	Producing the product	Delivering/ shipping the product
MC capability needed	Elicitation	Process flexibility	Logistics

Figure 7 Mass customization process phases and capabilities

Pine (1993a, 1993b) suggests five product-oriented ways to MC. One way is to *customize services around existing standardized products and services*. Tailoring is done by offering customer specific services that provide added value for the customer in addition to the standardized goods or services. Another way is to *modularize components to customize end products and services* i.e. to create modular components that can be combined in a number of ways into a wide range of different end products, like PCs for example. One way to achieve MC based on modularization is product configuration, which is in the focus of this thesis and discussed in more detail next in chapter 3.

2.3 Requirements for Mass Customization

This section briefly goes through some identified requirements for successful adoption and operation of MC. The following discussion is summarized in Table 1. The table contains the full list of references where the issues have been raised; the following discussion lists only example references to keep it more readable.

To be able to offer individualized products the *company must have detailed knowledge of the customer needs* (e.g. Hart 1995). The knowledge about the needs is required for two reasons. First, to be able to design products that meet varied customers needs the company must have an idea of what its customers generally want. Second, the customers have to express their individual preferences when specifying the product they want to buy. Knowing the preferences is not enough, however. The *company must have the process in place to translate the customer preferences to accurate product specifications* (e.g. Hart 1995) that are necessary to be able to produce exactly the product the customer wanted.

In MC where the production happens in response to varied customer needs *the sharing of knowledge is important* (e.g. Kotha 1995). Information must flow from the customer to sales and marketing through to production and distribution for the company to be able to produce the individualized solution for the customer. Naturally, the *products themselves must be customizable* for MC to be successful (e.g. Da Silveira et al. 2001).

Table 1 Internal MC implementation requirements

Internal MC implementation requirements
The company should have detailed knowledge of the needs of its customers and the means to get it, preferably in a collaborative relationship with the customers. (Hart 1995; Kotha 1996; Radder & Louw 1999; Zipkin 2001; Berman 2002; Broekhuizen & Alsem 2002; Steger-Jensen & Svensson 2004)
The company must have the process in place to translate customer needs into product specifications. (Hart 1995; Radder & Louw 1999; Da Silveira et al. 2001; Berman 2002; Broekhuizen & Alsem 2002; Svensson & Barfod 2002; MacCarthy & Brabazon 2003)
Knowledge and information must be shared. (Kotha 1995; Da Silveira et al. 2001; Zipkin 2001; Broekhuizen & Alsem 2002; Piller & Tseng 2003)
Products should be customizable. (Radder & Louw 1999; Da Silveira et al. 2001; Berman 2002; Broekhuizen & Alsem 2002)

2.4 BENEFITS AND CHALLENGES OF MASS CUSTOMIZATION

This chapter aims to give a brief overview of the benefits and challenges related to MC and customers. The benefits are summarized in Table 2 and the challenges in Table 3. Similarly as for Table 1, the tables contain the full list of references that have been omitted from the following discussion for brevity.

2.4.1 BENEFITS

An obvious benefit from MC to the customer is the *better fit between the needs of the customers and products offered* (e.g. Pine 1993a). The participation of the customer in the elicitation of needs and product preferences may make the *shopping experience more enjoyable* (e.g. Huffman

& Kahn 1998) and *increase satisfaction in the final product* (e.g. Bardacki & Whitelock 2003). The continuing dialogue with customers in detailed elicitation of customer needs potentially gives the company *an improved ability to analyze new product opportunities* (Berman 2002) and *more accurate information about demand* (Agrawal et al 2001). The continuing interaction with customers may give the company a competitive advantage as they get to *know their customers more deeply*, perhaps better than the competition (Bardacki & Whitelock 2003). Furthermore, once the elicitation has been done for the first time, it may be unnecessary to repeat some parts of it on future transactions. There is thus time invested in the relationship for both the company and its customers (Bardacki & Whitelock 2003). Switching to competition would mean going over the elicitation again and losing the time invested.

Table 2 Benefits from mass customization

MC benefits
Improved fit with customers' unique needs. (Pine 1993a, p. 127; Kotha 1995; Agrawal et al. 2001; Berman 2002; Broekhuizen & Alsem 2002; Bardacki & Whitelock 2003; MacCarthy & Brabazon 2003; Piller & Tseng 2003)
Customer's shopping experience may be more enjoyable (Huffman & Kahn 1998; Broekhuizen & Alsem 2002). Customer participation in the design may increase satisfaction (Huffman & Kahn 1998) with final product (Bardacki & Whitelock 2003; Piller & Tseng 2003).
Improved ability to analyze opportunities due to continuing dialogue with customers (Berman 2002). More accurate information about demand (Agrawal et al. 2001) and customers that could be used as a competitive advantage; knowing the customer better than competitors (Bardacki & Whitelock 2003).

2.4.2 CHALLENGES

An MC customer is often faced with several inconveniences. *Customized products tend to be more expensive* than standard products (e.g. Bardacki & Whitelock 2003), an issue closely related to price sensitivity of customers. Moreover, as customized products are usually produced, or at least the finishing touches made, in response to customer orders the *customer has to wait sometime before receiving the finished product* (e.g. Zipkin 2001).

Giving product preferences is related to several subtle challenges. First of all, the *customer has to spend at least some effort to the product specification* (e.g. Berman 2002). Furthermore, too often the customers are presented with an *overwhelming number of options,* which *may confuse* them (e.g. Pine 1993a). The *customers must also have sufficient confidence in giving preferences* to be able accept the risk of making wrong decisions (as by nature customized product may not be returned) (e.g. Berman 2002). Additionally, the *customers may see giving explicit preferences* and own information in the product specification *as an invasion of privacy* (e.g. Broekhuizen & van

Alsem 2002). As a MC customer usually does not get to see the finished product at the time of the sale it may be *difficult to judge whether the end product presents good value* (e.g. Broekhuizen & van Alsem 2002). This and the fact that customized products are more or less individualized means that *comparison-shopping is harder* for customers, which could lead to rising prices (Agrawal et al 2001). It is not as easy to find a matching product to compare to for a customized product.

Trust may be an issue too. The *customers have to trust the company to deliver the finished product exactly as specified*. Customers may be less tolerant of errors in delivery or deviations from the ordered product features as a customized product is exactly what the customer wanted (e.g. Berman 2002). Interestingly however, there is some evidence that the willingness of a company to customize its products for the customer creates trust in general (Doney & Cannon 1997) and also initial trust in an online environment (Koufaris & Hampton-Sosa 2004).

Table 3 Mass customization challenges

MC challenges
Increased price of the products (Hart 1995; Radder & Louw 1999; Agrawal et al. 2001; Svensson & Barfod 2002; Bardacki & Whitelock 2003; Piller & Tseng 2003; Goldsmith & Freiden 2004).
Waiting for the finished product (Radder & Louw 1999; Agrawal et al. 2001; Zipkin 2001; Svensson & Barfod 2002; Bardacki & Whitelock 2003; MacCarthy & Brabazon 2003; Piller & Tseng 2003).
Time and effort spent by customer in the product specification (Berman 2002; Broekhuizen & Alsem 2002; Bardacki & Whitelock 2003; Piller & Tseng 2003).
Overwhelming amount of options available may confuse customers. (Pine 1993a, p. 246; Beaty 1996; Huffman & Kahn 1998; Radder & Louw 1999; Zipkin 2001; Berman 2002; Broekhuizen & Alsem 2002; Svensson & Barfod 2002; Piller & Tseng 2003; Steger-Jensen & Svensson 2004)
Customers must have sufficient confidence in giving preferences to accept risk of making wrong decisions. (Berman 2002; Piller & Tseng 2003)
Customers may see giving explicit preferences in specifications as an invasion of privacy (Pine 1993a, p. 245; Broekhuizen & Alsem 2002; Pitta et al. 2003)
Limited transparency of customized product may hamper customer judgment of whether end product is good value. (Broekhuizen & Alsem 2002; Piller & Tseng 2003)
Comparison shopping harder for customers, could lead to price rise (Agrawal et al. 2001).
Customers need to trust the provider to deliver a specified product. No errors tolerated (as this is just what the customer wanted). (Berman 2002; Broekhuizen & Alsem 2002; Piller & Tseng 2003)

3 PRODUCT CONFIGURATION

This chapter describes one specific way of achieving MC and of special interest in this thesis, i.e. product configuration. First, configurable products and their characteristics are discussed in 3.1. Next, the development and sales-delivery processes in product configuration are described in 3.2. The challenges and requirements a company faces in product configuration are discussed d in 3.3 followed by an overview of information system support for product configuration, i.e. configurators, in 3.4.

3.1 CONFIGURABLE PRODUCTS

Product configuration is a one way to implement MC with modularized products, one of Pine's (1993a, 1993b) MC approaches, see 2.2. *Configurable products* have components that can be combined in a number of ways to meet a range of customer needs. Configurable products can be described by the following characteristics (Tiihonen & Soininen 1997; Tiihonen et al. 1998a).

- Each delivered product is adapted to the needs of a customer.
- The product has been pre-designed to meet a range of different customer needs. Needs outside the range are not meant to be met.
- Each product is specified as an arrangement of pre-designed components or modules. No new components need to be designed in the sales-delivery process.
- The product has a general pre-designed structure.
- A product instance can be specified in a routine manner in the sales-delivery process. There is no need to do creative design.

Often mentioned examples of configurable products are PCs and cars. One car buyer could want a convertible with a manual gearbox while another a station wagon with an automatic gearbox. From the manufacturer's point-of-view this means using different components for body and gearbox while the cars could be similar otherwise.

3.2 PROCESSES IN PRODUCT CONFIGURATION

When developing a configurable product the development process produces a *configuration model,* which defines the structure, components, and properties of the product and knowledge about the possibilities for adapting them to customer needs. A configuration model thus describes all possible instances of a configurable product. In practice, several configuration models describing the same product may be needed. For example, one model to be used in sales and another in engineering and manufacturing. (Tiihonen & Soininen 1997; Tiihonen et al. 1998a)

The information in a configuration model is used in the sales-delivery process to support the *configuration process* i.e. the specification of product instances adapted to customer needs. The result of the specification, a description of the product instance to be delivered, is called a *configuration.* The task needed to *configure* products to customer-specific instances is called a *configuration task* and the person that configures is referred to as a *configurer.* (Tiihonen & Soininen 1997; Tiihonen et al. 1998a)

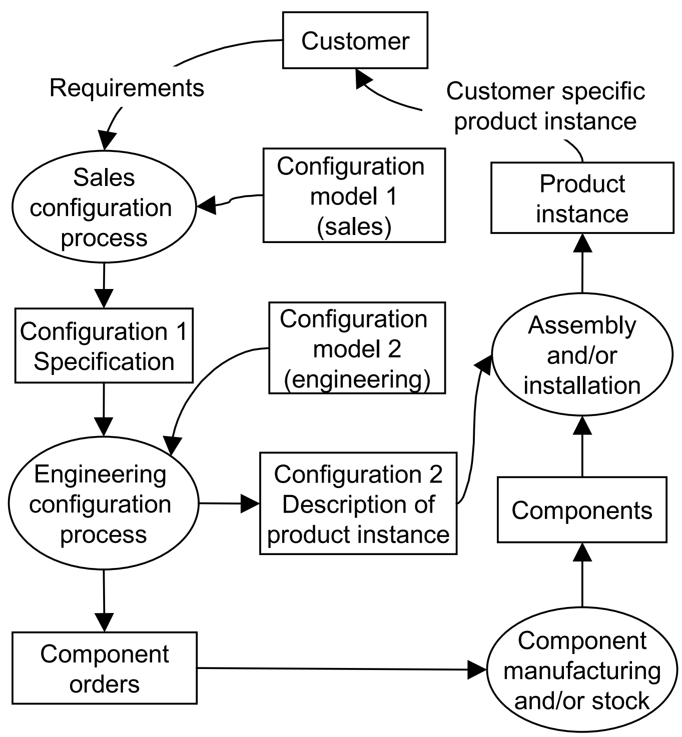

Figure 8 Sales-delivery process of configurable products, adapted from (Tiihonen et al. 1998a)

Figure 8 describes a typical sales-delivery process of configurable products, or in this case, one geared towards goods. The process is initiated by a customer order. In the sales configuration process the requirements of the customer are interpreted and concretized - using the information in a sales configuration model - to a sales specification (*configuration 1*). Next, in the engineering configuration phase the sales specification is used together with an engineering configuration model to create a description of the product instance that is accurate and concrete enough to be used in assembly or manufacturing (*configuration 2*). The final customer-specific product instance is then delivered to the customer.

All the phases of the sales-delivery process might not be needed, depending on the characteristics of the product. For example, simple products, like PCs, might require only the sales configuration phase and the configurer could be the customer himself. On the other hand, for complex products like capital goods, the sales personnel might not have the required expertise to configure the products without support from product experts and an engineering configuration would be necessary. (Tiihonen & Soininen 1997; Tiihonen et al. 1998a)

3.3 Challenges in Product Configuration

Product configuration faces some challenges, which are briefly discussed in the following. The discussion is summarized in Table 4. The table contains all the references, some of which have been omitted from the text for brevity.

First of all, the move to offering and producing configurable products may incur considerable expenses and require big development efforts (e.g. Forza & Salvador 2002a). The products have to be modularized (Tiihonen et al. 1998a). The product knowledge, which often resides only in the heads of product developers, has to be systemized and spread across the organization (e.g. Forza & Salvador 2002a). Creating the product model can be huge task (Forza & Salvador 2002a, 2002b). In the case the move to configurable products takes place from the direction of one-of-a-kind products (see Figure 6) the sales personnel must learn not to offer unnecessary changes (Tiihonen et al. 1998a). When moving from the direction of mass production, sales and production must take more specification tasks (Tiihonen et al. 1998a) and the processes of the company must be altered to handle customer-specific products (e.g. Forza & Salvador 2002a). Implementing the required changes may prove to be difficult (Tiihonen & Soininen 1997).

The challenges in product configuration are not limited to implementing changes to products, processes, or organization. Product configuration requires good elicitation capability (Forza & Salvador 2002a, see also 2.2) and the ability to translate customer requirements to production specifications (Forza & Salvador 2002a, see also 2.3 and Table 1) from the company. Many of the problems arise in the sales configuration process. Often the sales specifications are *incomplete*, i.e. miss some necessary information for manufacturing, or *invalid,* i.e. they contained errors: it was not possible to manufacture the product based on the specifications (e.g. Tiihonen et al. 1998a). One error source may be the misunderstandings between the customer and the sales staff (e.g. Tiihonen & Soininen 1997). This may be attributed to differences in the language customers use to describe their requirements and how the company describes the characteristics of its products (Forza & Salvador 2002a).

Ensuring that the sales or engineering configurations are valid and complete often incurs long lead times to the process (e.g. Tiihonen & Soininen 1997). Sales personnel do not necessarily have the (technical) product expertise required to produce a valid and complete configuration. Often the sales personnel may have to rely on the technical staff to ensure a configuration's feasibility, which causes delays (e.g. Forza & Salvador 2002a). Discovering errors after the sales configuration and needing to check the configuration feasibility from the engineering staff causes iteration in the sales-delivery process (e.g. Sabin & Weigel 1998), as illustrated in Figure 9. Long response times, configuration errors, and wrongly interpreting customer requirements all may have negative effects on customer satisfaction (Forza & Salvador 2002a).

The sheer volume (Forza & Salvador 2002a, 2002b) and complexity (Fohn et al. 1995) of the configuration specification tasks may strain both the sales and technical staff to the end that the validation may not be done. Additionally, the sales people may, in response to the complexity of the specification task, confine themselves to offering only a "repertoire" of typical configurations (Sviokla 1990; Salvador & Forza 2004). This means that the full scale of product instances the company can produce is not offered to customers.

Further, the number of different configuration specifications increases the need for information management (e.g. Forza & Salvador 2002a). It is more difficult for the company collect, store, and process the larger amount of information about the customer orders. The variety in the offered product capabilities can affect both what the product can do and how it has to be used and maintained.

Some of the problems may be due to inadequately documented and maintained configuration models (e.g. Tiihonen et al. 1998a). Maintaining the configuration knowledge is thus an important problem in product configuration. Another source of problems may be the complexity of configurable products. Rules for the adaptation may be highly interdependent and difficult to grasp for configurers (e.g. Soininen 2000).

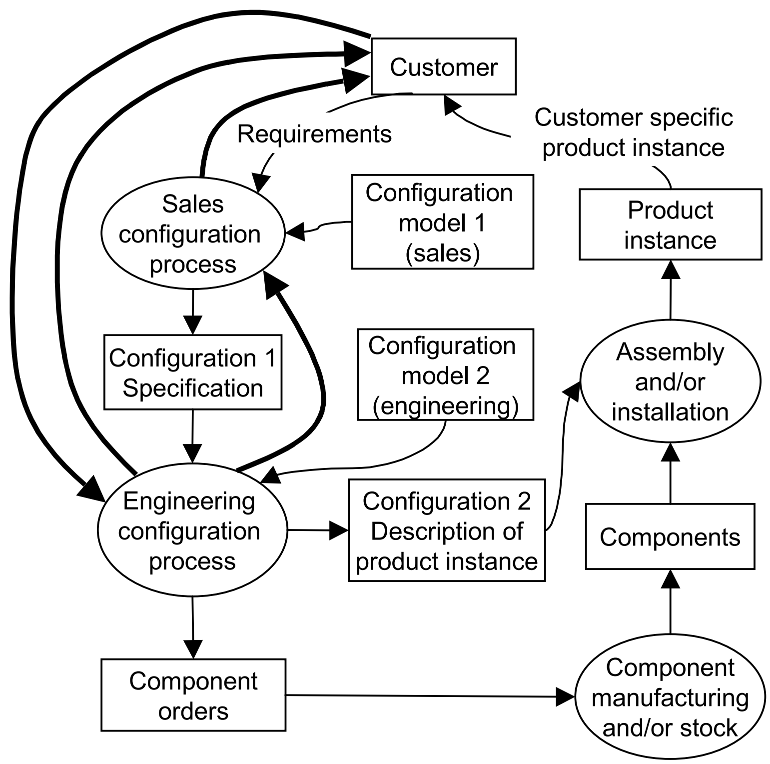

Figure 9 Sales-delivery process of configurable products, with unwanted iteration due to erroneous specifications, adapted from (Tiihonen et al. 1998a)

Table 4 Product configuration challenges and requirements

Product configuration challenges and requirements
Move to configurable products may incur considerable expenses, require big development efforts, and be difficult (Forza & Salvador 2002a, 2002b; Tiihonen & Soininen 1997; Kruse & Bramham 2003)
Product knowledge has to be systemized (Forza & Salvador 2002a, 2002b; Tiihonen et al. 1998a; Salvador & Forza 2004).
Sales personnel must learn not to offer unnecessary changes, when moving from to configurable products from craft production (Tiihonen et al. 1998a).
Sales and production must take more specification tasks, when moving to configurable products from mass production (Tiihonen et al. 1998a).

Processes must be changed to handle customer-specific products (Forza & Salvador 2002a; Tiihonen et al. 1998a).
Good elicitation capability is needed (Forza & Salvador 2002a).
Ability to translate customer requirements to production specifications is needed (Forza & Salvador 2002a).
More need for information management as number of different customer specific configurations increases (Forza & Salvador 2002a; Steger-Jensen & Svensson 2004).
Sales specifications are often incomplete or invalid (Tiihonen et al. 1998a; Forza & Salvador 2002a, 2002b; Salvador & Forza 2004; Sviokla 1990; Steger-Jensen & Svensson 2004).
Misunderstandings between the customer and the sales staff possible in the sales stage (Tiihonen & Soininen 1997; Forza & Salvador 2002a).
Ensuring that the sales or engineering specifications are valid and complete incurs long lead times (Tiihonen & Soininen 1997; Tiihonen et al. 1998a; Forza & Salvador 2002a, 2002b; Ranze et al. 2002; Steger-Jensen & Svensson 2004).
The reliance of sales personnel on technical staff to check feasibility of configurations causes delays (Forza & Salvador 2002a, 2002b; Ranze et al. 2002; Fohn et al. 1995; Tiihonen & Soininen 1997; Tiihonen et al. 1998a; Sabin & Weigel 1998; Steger-Jensen & Svensson 2004) and iterations to the sales-delivery process (Sabin & Weigel 1998; Tiihonen et al. 1998a; Ranze et al. 2002).
The volume (Forza & Salvador 2002a, 2002b) and complexity (Fohn et al. 1995) of the configuration task may strain the sales and technical staff to the end that feasibility checks may be left undone (Sviokla 1990; Forza & Salvador 2002a, 2002b; Salvador & Forza 2004).
Proper documentation and maintenance of configuration models important (Tiihonen et al. 1998a; Soininen 2000; Forza & Salvador 2002b; Fohn et al. 1995; Kruse & Bramham 2003).
Complexity of configurable products may be hard to grasp for configurers (Soininen 2000; Salvador & Forza 2004).

3.4 CONFIGURATORS

This section first gives an overview of configurators 3.4.1 and then discusses the benefits that can be achieved by using them in 3.4.2.

3.4.1 OVERVIEW

Product configuration can be supported with an information system called *product configurator,* or *configurator* for short. Configurators are used for two different tasks (Tiihonen & Soininen 1997; Soininen 2000), a division also evident in configurators described by Vanwelkenhuysen (1998) and Tiihonen et al. (2003).

The tasks:

- To support the customer and/or sales person in eliciting customer needs and translating them into product specifications.
- To model the adaptation possibilities of configurable products into configuration models, and to maintain and manage the product knowledge embedded in the models.

The first task is illustrated in Figure 10. Initially, the needs of a customer are interpreted as the requirements the to-be-specified product instance should have. Then the *configuration engine* takes the requirements as input and tries to construct a *suitable* configuration, i.e. one that satisfies the requirements, that also conforms to the rules on how the components can be combined, i.e. is *correct*. The rules represent the adaptation possibilities of the configurable product and are documented in a configuration model, the output of the second task. The resulting configuration is an accurate enough a description of a product instance. (Soininen 2000)

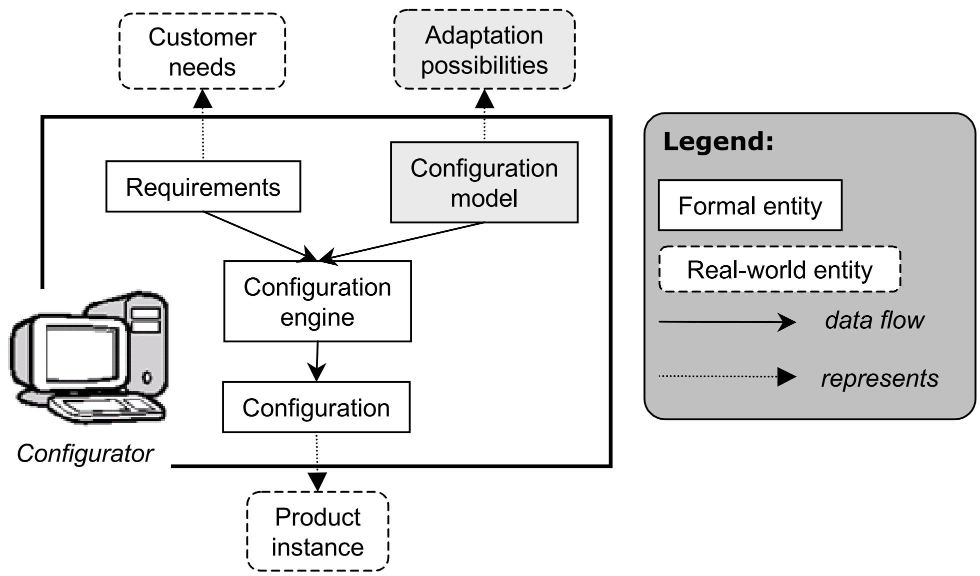

Figure 10 Configuration task with a configurator, adapted from (Soininen 2000)

The configuration model is defined using a *configuration modeling language,* which is a formal language based on a *conceptualization*, or in other words a *conceptual model*, of knowledge on configurable products.

The configuration specification process using a configurator is shown in Figure 11. The configurer, often a customer and/or a sales person, is presented with the possible adaptation options defined in a configuration model. Based on the customer needs and the presented options, the configurer selects an option of his/her choice. The configuration process repeats this cycle until a configuration, which is correct as specified in the configuration model and satisfies the needs of the customer, is achieved.

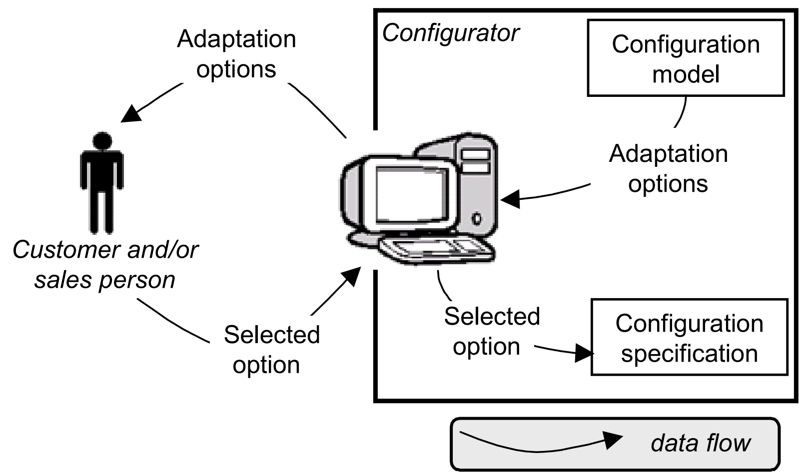

Figure 11 Configuration process with a configurator, adapted from (Scheer et al. 2003)

3.4.2 *Benefits from Configurators*

The following discussion is summarized in Table 5. It contains the full list of references some of which are omitted from the text for brevity.

A configurator can ensure the *correctness*, i.e. both the *validity* and *completeness* of a configuration, thus eliminating errors (e.g. Tiihonen & Soininen 1997). Eliminating the specification errors from the sales-delivery process leads to a process without unnecessary, time consuming, and costly iterations (e.g. Tiihonen & Soininen 1997), as illustrated in Figure 12.

The support a configurator lends to the specification process can make it quicker. Overall, configurators can help to ensure almost 100% correctness in configurations and significant reductions in lead-times of the sales-delivery process (e.g. Sviokla 1990). Using a configurator can help a company to increase the volume of quotations without increasing sales staff (e.g. Tiihonen & Soininen 1997).

The support a configurator lends to the elicitation of customer needs and requirements can make the elicitation process quicker and more enjoyable for customers and get them more involved in it (Reed et al. 2004). According to Steger-Jensen & Svensson (2004), a configurator can ease the uncertainty arising from an overwhelming number of options and needing to make customization decisions without sufficient knowledge about the product, both challenges in MC (see Table 3).

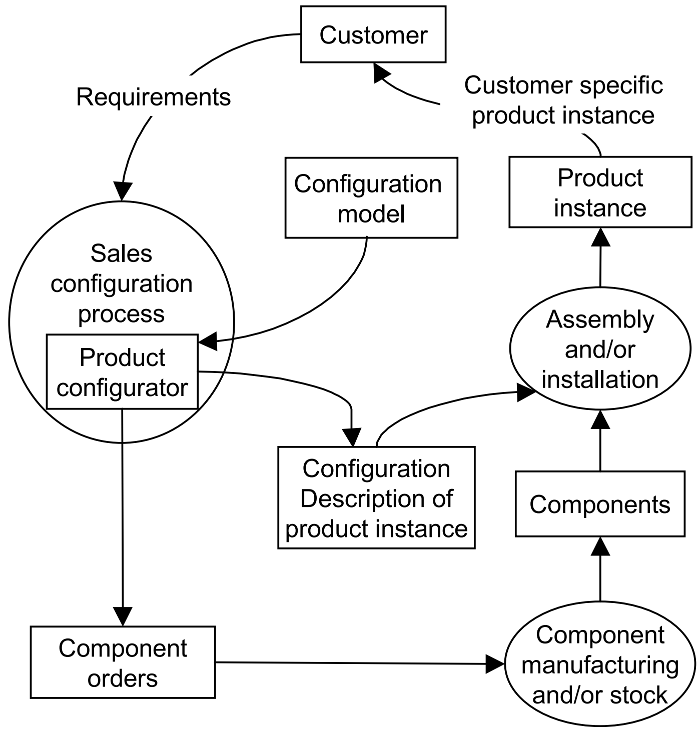

Figure 12 Sales-delivery process with configurator support, adapted from (Tiihonen & Soininen 1997)

Configurators can also help in maintaining the product knowledge (e.g. Yu & Skovgaard 1998) and distributing it to people in all phases of the sales-delivery process (e.g. Jørgensen 2001).

Table 5 Benefits from configurators

Configurator benefits
Elimination of errors from configurations (Tiihonen & Soininen 1997; Yu & Skovgaard 1998; Slater 1999; Forza & Salvador 2002a, 2002b; Ranze et al. 2002; Steger-Jensen & Svensson 2004).
Elimination of time consuming and costly iterations from the sales-delivery process (Tiihonen & Soininen 1997; Vanwelkenhuysen 1998; Forza & Salvador 2002a, 2002b).
Reduction of lead times, a quicker specification process (Sviokla 1990; Forza & Salvador 2002b; Steger-Jensen & Svensson 2004; Ranze et al. 2002; Frutos & Borenstein 2003; Vanwelkenhuysen 1998).
Increase of the volume of quotations without increasing sales staff (Tiihonen & Soininen 1997; Vanwelkenhuysen 1998; Sviokla 1990).
Configuration task may be more enjoyable for customers (Reed et al. 2004).
Easing the uncertainty from overwhelming number of product options and insufficient product knowledge of customers (Steger-Jensen & Svensson 2004).
Easier maintenance of product knowledge and configuration models (Yu & Skovgaard 1998; Jørgensen 2001; Tiihonen & Soininen 1997; Jørgensen 2001).
Support for distributing product knowledge to the organization (Jørgensen 2001; Forza & Salvador 2002b; Frutos & Borenstein 2003; Steger-Jensen & Svensson 2004).

4 SERVICES

This chapter first discusses services in 4.1 in general and presents some definitions and viewpoints to services, which followed by a description of the differences between services and goods. An overview of found literature on the customization of services follows in 4.2 and of service design and development in 4.3. Current support for configuration of services is touched upon in 4.4. The chapter concludes with a recap analysis of the service literature in 4.5.

4.1 GENERAL

Service is a complicated phenomenon and a difficult term to define, partially because it is extensively used in many different contexts. This difficulty has prompted Johns (1999) to write an article called "*What is thing called service?*" and even Christian Grönroos, a well-known authority on services, "reluctantly" proposes in (Grönroos 2000, pp. 46) the following definition for services. "A service is a process consisting of a series of a more or less intangible activities that normally, but not necessarily always, take place in interactions between the customer and service employees and/or physical resources or goods and/or systems of the service provider, which are provided as solutions to customer problems." Another definition is given in (Fitzsimmons & Fitzsimmons 2004, p. 4): "A service is a time-perishable, intangible experience performed for customer acting in the role of co-producer". Fitzsimmons & Fitzsimmons (2004, p. 4) also list other service definitions. "Services are deeds, processes, and performances." "A service is intangible and perishable. It is an occurrence or process that is created and used simultaneously or nearly simultaneously. While to consumer cannot retain the actual service after it is produced, the effect of the service can be retained." Johns (1999) characterizes services as trying to meet customer needs through actions.

Even if services are often defined as being intangible, a service often includes a tangible component, i.e. goods like in car maintenance, according to Fitzsimmons & Fitzsimmons (2004, p. 21). They and Grönroos (2000, p. 47) list distinctive characteristics of services:

- **Customer participation:** The customer is often an active co-producer in the service process. Usually the customer has to be present at least in some point during the service delivery. In goods, the customer usually just receives the finished product, although he might have participated in the design or specification, which is often the case in MC.

- **Simultaneity of production and consumption:** Services are created and consumed simultaneously, therefore services cannot be stored. On the other hand, goods can be kept in stock. In other words, in goods the production and distribution are separated from consumption whereas in services these happen simultaneously and are inseparable. The customers perceive that both service process and its outcome contribute to the quality of a service.

- **Perishability:** Services cannot be used again. If a seat on a flight is left unoccupied that specific seat on the flight cannot be sold again.

- **Intangibility:** Services are more or less intangible processes whereas goods are tangible things. A customer cannot easily evaluate a service beforehand, as opposed to goods. One can test drive a car, for example, but testing a restaurant evening is more difficult.

- **Heterogeneity:** Services vary from customer to customer because of the participation of the customer in the process and their intangible nature. On the other hand, goods are homogenous. However, service customers want to be treated fairly and receive the same service as others do.

- **Transfer of ownership:** The ownership of goods can be transferred whereas a service usually doesn't result in an ownership of anything.

- **Value production:** In services, the company produces the core value for the customer in buyer-seller interactions. In goods, the company produces the core value in a factory.

According to Jiao et al. (2003) service is understood in literature along two main streams: as an activity or as an output of a system. When understood as an activity a service is performed for others, usually the customers. As an output a service is "a deed", "a performance", "an offering", or "a benefit". This kind of dual view echoed by Jiao et al. (2003) is presented in (Grönroos 2000, pp. 51, 63). From the service provider's view, much of the service management deals with the *process* and *outcome* consumption. A satisfactory outcome, i.e. *what* a customer receives in interactions with a company, in other words a result of a process, is necessary and a prerequisite for a good perceived quality of a service. However, *how* a customer receives the service and experiences the service process has a great influence on the customer's satisfaction with the service. Grönroos (2000, pp. 63-4) argues that the service quality seen by customers has two dimensions: a technical (what received, outcome) and functional (how received, interactions, process) quality. Thus, managing the service process is important.

Usually a service process includes interactions of the service personnel and customers. Therefore both the personnel and customers influence service quality. The interpersonal interaction the personnel provide has the biggest impact on customer satisfaction (Johns 1999). However, the parts of the process not visible to the customers do influence the customer satisfaction with the service also. For example, the quality of a restaurant meal is usually the responsibility of the chef, and the meal is prepared in the kitchen out of sight of the customer. The customer participation has an effect on the process: customers can provide resources needed as inputs in the process (Fitzsimmons & Fitzsimmons 2004, p. 331). The inputs they give and the actions they take may vary in general and in quality. This means that the service company faces difficulties in delivering quality service, both process and outcome wise, because of the varied actions and inputs of the customers. Educating and informing the customers about how they should act in the process is a way to make their actions more predictable and less varied (Grönroos 2000, p. 221; Johns 1999).

The customers' expectations of the service may be unclear and even unrealistic (Fitzsimmons & Fitzsimmons 2004, p. 104). The customer expectations can be managed with putting effort to communicating clearly what the customers can realistically expect from the service, before and during the service process (Fitzsimmons & Fitzsimmons, 2004, p. 331). Related to communicating expectations, Grönroos (2000, p. 244) sees that services involve the company giving a promise and fulfilling the promise. The customer actions and expectations can be managed with the promise, specifying beforehand what the customer can expect to receive and needs to do in order to receive the service. How the promise is then actually fulfilled results in a service experience perceived by the customer.

The customer's service experience depends also upon the perceived control and choice (Fitzsimmons & Fitzsimmons 2004, p. 106; Johns 1999). The more in control the customer perceives to be the more positive the effect is. The existence of choice can in its own right enhance the customer experience. The perceived control is an issue especially in services where the relative expertise and competence gap between the provider and the customer is significant. In such services, like medicine and law, the customer may feel at the mercy of the service provider. Being able to make choices also enhances perceived control. Self-services give the customer more control and often also choice, e.g. choosing when and where to access the service. Another issue in services is trust (Grönroos 2000, p. 37, 81). As services often involve the company giving a promise to deliver the agreed upon service and the customer cannot examine the service before its consumption, the customer has to trust the company to actually deliver the service. The need for trust is heightened should there be a gap between provider and customer expertise.

Johns (1999) argues that there is a clear dichotomy between how the customers and providers see services. From the providers' point of view the service process has elements of core delivery and interpersonal performance that need to be managed in different ways in different service industries. For the customers, the service contains elements of core benefit and personal experience, which are present in service encounters and service outcomes. The provider view concentrates on the process of service operation whereas the customer views a service as an experience phenomenon. Johns' (1999) main argument is that the provider-oriented concepts of services should not be equated with the customer-oriented ones. The service companies often use verbs to describe a service, emphasizing the process, as on the other hand the customers employ nouns to indicate the benefits they have received. Akkermans et al. (2004) also argue that there is a need to clearly distinguish customer- and provider-oriented service descriptions.

4.2 SERVICE CUSTOMIZATION

According to Merriam-Webster Online[2], to customize is to build, fit or alter according to individual specifications. In product configuration, the product is built by combining pre-designed components according to the individual specifications. Following this, *service customization*, in this thesis from here onwards, is defined as the act of building, fitting or altering a service to individual specifications, done in a systematic way.

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[2] Merriam-Webster Online Dictionary, http://www.m-w.com/

Diverse customer needs can be met by customizing products but also by increasing the variety of products offered by the company i.e. broadening the product range. Martínez-Tur et al. (2001) argue this to be a popular strategy in services. Increasing service offering variety has its downsides too. Increasing variety of the service offering or customizing the services increases variation and complexity in the company's operations, which means a rise in costs. Thus, the challenge is to broaden the range of services offered without risking performance (Harvey et al. 1997), which seems similar to MC, see 2.1. Complexity increases problems in quality control (Martínez-Tur et al. 2001). Excessive complexity can be confusing for customers (see also Huffman & Kahn 1998 and 3.3), which in turn may lead to decreased customer satisfaction. Communicating the value added to customers from a complex offering is problematic (Devlin 1997), an issue emphasized by the intangibility of services (Mathyssens & Vandenbempt 1998), see 4.1.

In MC literature modularization is touted as one way to manage costs of customization, see 2.2 and 2.3. Modularization as a way to customize services seems not to be a much-researched subject. Nevertheless, mixing and matching modules in response to customer needs has been suggested by Quinn & Paquette (1990), MC proponents Pine et al. (1993), McLaughlin (1996), Peters & Saidin (2000), Tether et al. (2001), and Meyer & DeTore (1999; 2001). All of them seem to be of the general opinion that service modules represent specific processes or tasks (like performing a credit card check). A key challenge is to have a linkage system in place that brings together the necessary modules swiftly in response to customer needs.

4.3 SERVICE DESIGN & DEVELOPMENT

This chapter reviews the literature on service design and development with a focus on issues that are deemed important enough to be designed in services. This can shed light on what should be modeled of services for configuration purposes as well.

Goldstein et al. (2002) argue that the *service concept* is a central figure in service design and development. The service concept describes *what* customer needs the service company intends to satisfy, i.e. the benefits for the customer, *how* this is to be achieved and what is to be done for the customer, and *with what* kind of resources (Goldstein et al. 2002; Edvardsson & Olsson 1996; Grönroos 2000, pp. 193). Bitran & Pedrosa (1998) argue that the intangibility of services makes it more difficult in design to understand *what* the customers want, *why* they want it, and *how* to deliver it. All are issues that they deem important to define during service development.

Goldstein et al. (2002) discuss the pros and cons of deconstructing a service into its components or into *what* and *how*. A benefit is that the designers can identify the various elements of the service and check them against the customers' needs and consequently design and deliver the elements. However, a service may be seen as whole experience by customers rather than as a collection of service components. Goldstein et al. (2002) raise the question of whether customers buy specifications or do they have a single mental picture of the service in mind instead. The issue is interesting for service configuration too as in product configuration it is just the specifications that the customers see at first.

Applying the concepts of architecture and modularity is an area for future research in service development (Ma et al. 2002; Menor et al. 2002). Modularity and architecture are key issues in MC and product configuration as well, see 2.2 and 2.3. The following takes a look at the few existing articles with a service development or design point-of-view and that discuss modularity.

Meyer & DeTore (1999; 2001) approach service design by using product platform concepts that have been used for developing physical products. They see the product platforms as subsystems that can be reused over product line borders and their interfaces. Their approach begins with segmenting customers and understanding their *needs*, both perceived and latent. The *subsystems are then developed to meet a certain range of needs*. A subsystem defines *processes to fulfill customer needs*. The processes are standardized as much as possible. The development defines also the *skills and competencies necessary for a successful process implementation*. The platform of subsystems is then used to customize the service by mixing and matching the processes of various subsystems to the needs of specific customers.

Jiao et al. (2003), Bullinger et al. (2003, see 5.4.1), and Scheer et al. (2004, see 5.4.2) define design approaches that use different dimensions to describe services. In synthesis, the following dimensions can be identified. First, a dimension incorporating the *benefits* the service tries to convey to its customers that could possibly be captured with a hierarchy of customer *needs*. Second, a dimension describing the *service contents*, its outcomes, *what* a service does. Third, a dimension for describing the *process* used to deliver the benefits and outcomes and the *customer's participation* in the process. And fourth, a dimension capturing the different *resources required* in the process.

Ma et al. (2002, see 5.4.3) represent a design technique for services. They view a service product as a *customer service experience*. A *customer* in their eyes *can be an individual person, group of people or organization*. Their design technique focuses on the *customer's participation* in the service delivery process. The customer leaves the process with experiences added and can have received information or facilitating goods. The activities the customer takes are the central concept. The *resources* the activities need as input are included as well. These are for example contact employees and inanimate physical evidence.

4.4 Configuration of Services

This section discusses the support for services in current configurators. It draws heavily on (Heiskala et al. 2005).

The configurator support for services can be divided into two categories: *extended product configurators* and *industry specific service configurators*. Extended product configurators are configurators, which can be used for configuring both goods and services. Industry specific service configurators are intended only for configuring services in a certain service domain.

Literature describing the service configuration support in the current configurators is very limited. The ILOG JConfigurator (Junker & Mailharro 2003; Mailharro 1998) and the CAWICOMS Workbench (Ardissono et al. 2003a; Ardissono et al. 2003b) are examples of extended product configurators, which support the configuration of both goods and services. The ILOG JConfigurator has been used in financial services configuration. The CAWICOMS Workbench is designed to support the configuration of physical and service products in the telecommunication domain. In both systems the concepts used for modeling are the same as for goods and no service specific modeling concepts are presented.

The PSC+ system (Stolze et al. 2000) and the SmartClient technology (Torrens et al. 2002) represent industry specific service configurators. The PSC+ system is used for choosing and configuring insurance services. The SmartClient technology has been applied to an air travel planning system. The systems do not define a conceptualization for services.

Due to the lack of literature on service configurators, the marketing information available at the web-sites of 30 commercial configurator vendors was analyzed in (Heiskala et al. 2005). The result was that most vendors (20/30) claim to support services. However, the information provided about service configuration was limited. Only three vendors described the concepts used for modeling products and none of them introduced any service specific modeling concepts. The four industry specific service configurators provided service configuration as part of more complete sales systems.

Service configuration has been at least a partial goal in several papers. Of these, Winter (2001), Böhmann et al. (2003), Jiao et al. (2003) do not define a conceptualization for configuration modeling of services but do discuss service modeling issues. Meier et al. (2002) do not present a conceptual model either but mention a configurator implementation, albeit very briefly. Dausch & Hsu (2003a, 2003b) propose a reference model for mass customization of services but do not have tool support. Wimmer et al. (2003) define a conceptualization for financial services configuration but lack tool support. Tool support and a conceptual model is presented in the work of Baida et al. (Baida et al. 2003a; 2003b; 2003c; 2004a; 2004b; Akkermans et al. 2004). The work mentioned in this paragraph will be discussed in more detail in 5.2 and 5.3 that deal with the service modeling issues.

4.5 Summary and Analysis of Services Literature

This section analyses the literature on services with an aim to come up with issues that could, and perhaps should, be captured in the conceptualization for modeling configurable services.

There are a few issues that the service literature seems to have a relatively common mutual understanding on. A service is a *process*. A service process produces *outcomes* received by the customer. The outcomes should solve *customer problems*, meet customer *needs*, and/or produce *benefits* for the customer. The customers see the service as an *experience* that is influenced by both the service process and its outcomes. In service design it is seen as important to identify the *needs* and *wishes* the customers want to satisfy and the *benefits* they seek from the service. *How* this is to be achieved, i.e. the process, is naturally important too, and *with what* kinds of *resources* like the facilities and the required competencies of personnel.

The *customer* often *participates in* the *process*. The varying customer actions influencing the process can make it difficult for the company to deliver quality service. Services are intangible and they cannot be tested beforehand. Therefore services can be understood to involve the company giving a *promise* and then fulfilling the promise. Because of the intangibility of services, customers' *expectations* of both the service outcomes and their role in the process may be unrealistic. How well the customer participation and expectations are managed has an impact on the customer satisfaction with the service. Therefore, it is advisable to educate the customer beforehand about his role in the process and what he can realistically expect to receive from the service.

Modularization is seen as one way to achieve service customization. The customization should happen by combining and matching modules. Usually the modules are seen as work tasks, parts of a process, or in other some other way divisions of activities. A system that effectively and seamlessly combines the modules in response to specific customer needs is required.

Figure 13 shows a high level conceptualization of services based on the service literature covered in chapter 4. The conceptualization attempts to summarize the preceding discussion. A *customer* has *needs* that he wants to be fulfilled. The *outcomes* resulting from the service *process* should satisfy them. The service process requires certain *resources* in its operations. The *customer participates* in the process and has expectations, possibly unfounded ones, of the outcomes and his role in the process. The needs describe *why* a customer buys the service and the outcomes in turn *what* the customer is buying. The process describes *how* the service is delivered whereas *resources* define *with what* the process is realized.

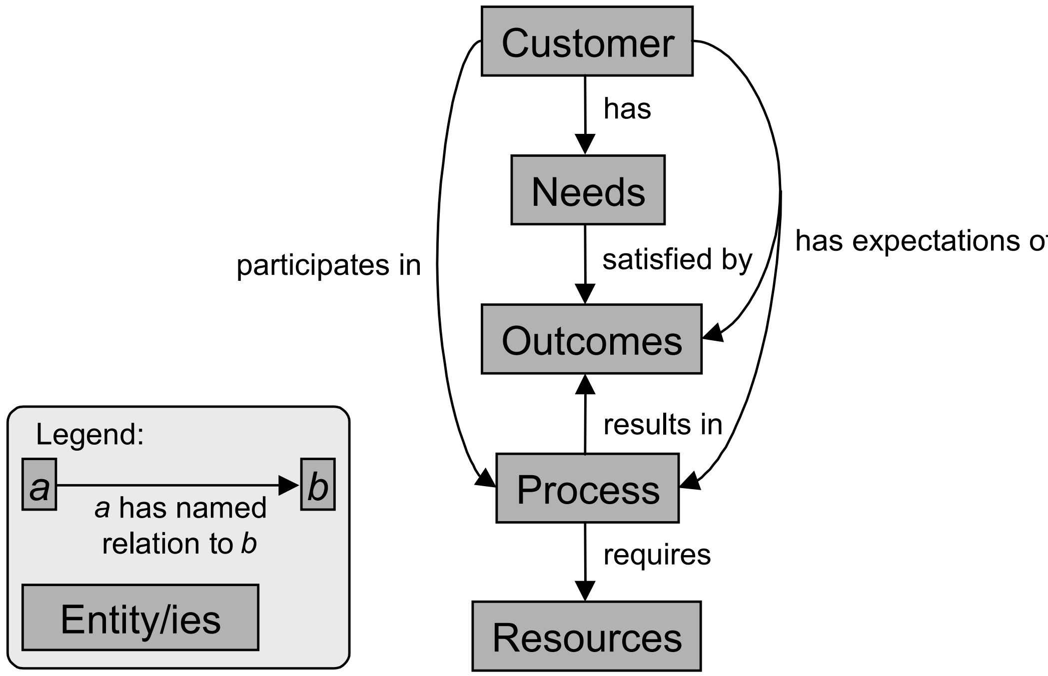

Figure 13 A high level conceptualization of services based on service literature

On basis of the covered service literature the conceptualization presented in Figure 13 aims to describe the issues that perhaps should be captured in the service configuration conceptualization. However, Johns (1999) stressed the point that customers and providers perceive services differently. The providers use verbs to describe the service and emphasize the process and service operation whereas customers use nouns and view service through the benefits they receive and how they experience it. Therefore a conceptualization done from customer perspective should not necessarily include provider-oriented concepts.

5 MODELING APPROACHES

This chapter reviews different modeling approaches found relevant enough to warrant a closer inspection. In 5.1 two product configuration conceptualizations are discussed. A modeling approach for service configuration is described next in 5.2 followed by a discussion of some domain-specific service conceptualizations in 5.3. Models that have emerged in the service design and development field are described in 5.4. The chapter concludes with a comparative analysis of the most relevant modeling approaches and an integrative discussion of what is required of a service configuration conceptualization.

5.1 CONFIGURATION CONCEPTUALIZATIONS

This section discusses two central product configuration conceptualizations.

5.1.1 SOININEN ET AL.

Soininen et al. (1998) present a generalized ontology of product configuration. Their ontology is a synthesis of the main approaches to present configuration knowledge, i.e. *connection-, resource-, structure-,* and *function-based* approaches. As such it is relatively representative of product configuration ontologies i.e. conceptualizations. In (Tiihonen et al. 1998b) the conceptualization and its recommended usage are illustrated. Tiihonen et al. (1998b) also evaluate its feasibility with a case example of modeling a real configurable product. A research prototype configuration tool called WeCoTin partially supports the use of the conceptualization (Tiihonen et al. 2003). However, Soininen et al. (1998) concede that their conceptualization - in taking a product configuration view (of goods) - may lack concepts to cover all things required for configuration design. It also does not cover knowledge on pricing or optimization of configurations.

Soininen et al.'s (1998) conceptualization distinguishes between *types* and *instances,* called *individuals*. The types and the different relations between them are used to describe the possible correct configurations in a configuration model. The individuals of the types occur in a configuration that specifies an actual product instance. There are four different types: components, ports, resources, and functions. A type defines the *properties* it can have, like attributes, parts, and ports. Types can be organized in classification taxonomies with inheritance defined by *is-a* relations between the types, i.e. in a *generalization* hierarchy. A type *inherits* the properties of all its *supertypes* in the generalization hierarchy. A *subtype* can *refine* the properties it has inherited.

Generalization is useful when a set of types has common properties or need to be referred collectively. Collecting the common properties to supertypes can help keep the configuration model more compact and thus more maintainable (Tiihonen et al. 1998b; Soininen et al. 1998). The difficulty of maintaining configuration knowledge is one of the main challenges in product configuration, see 3.3.

A type can define attributes. An *attribute* represents the characteristics of an individual of the type. A type defines the *possible values* its attributes can have. Attributes are used to parameterize types (Tiihonen et al. 1998b).

The *compositional structure* of a configurable product is described through component types and their parts. A *component type* represents a distinguishable entity in a product that is meaningful for product configuration. A component type describes its parts through part roles specified with *part definitions*. For each part definition a component type specifies a *part name* identifying the part, possible part types, and a cardinality. The *possible part types* are a set of component types whose individuals are allowed to occur in the role with the associated part name. A *cardinality* indicates the number of component individuals that must occur as parts with the part name.

The *topology* of the product, i.e. the possible connections between its component types, is described with port types. A component type specifies *port definitions* that include a port name, possible port types, and a cardinality. The *port name* identifies the port. *Possible port types* in turn specify the port types that can be connected to the port. The *cardinality* defines the number of port individuals the port must have connected to it. A port individual describes a place at which two component individuals can be connected to each other. The semantics of the connection modeled with ports is that there is a physical or logical connection between the port individuals and the component individuals containing them.

Resources are used to model the production and use of entities or flow of entities between component individuals in some defined quantities (Soininen et al. 1998). A *resource type* defines whether the production and use of the resource must be balanced or satisfied. For a *balanced* situation, the production must exactly match the use whereas for a *satisfied* situation the production must be equal or higher than use. The component types define in *production* *definitions* and *use definitions* the resource types and the quantities produced or used by the individuals of the type respectively.

Soininen et al. (1998) call the concepts introduced so far technical concepts, a clear indication of the orientation of the conceptualization, i.e. product configuration of goods. However, they do represent concepts, which describe the functionality a product individual provides to the customer, the user of the product, or the environment where the product will be situated. These concepts can be utilized especially in the sales configuration phase (see Figure 8) as inputs for the technical configuration that operates with the technical concepts.

Main concept in the functional view is function type. A *function type* is an abstract characterization of the product that a customer or sales person would use to describe what the product can be used for, or what need the product satisfies. The hierarchical breakdown of a function to *subfunctions* is described with part definitions. They are defined in a similar fashion as part definitions of component types with the exception that the possible part types must be function types. Functions are related to technical concepts in the sense that a several different combinations of technical concepts may implement the same functions and one combination of technical concepts may implement several functions. This relation is modeled with *implementation constraints*. The constraint concept is discussed further below. The possible combinations of functions a product can implement are restricted with *specification constraints*.

A constraint is a general mechanism to model interdependencies between types, individuals of types, and their properties whose intended meaning cannot be adequately or conveniently modeled using the concepts introduced above. A *constraint* is a formal, logical and/or mathematical, rule that specifies a condition that must hold in a correct configuration.

The implementation of the conceptualization of Soininen et al. (1998) is extended in (Pasanen 2003) with soft constraints and default values. *Soft constraints* are defined in the same way as (hard) constraints, see above, but their semantics are a bit different. The condition described by a soft constraint is preferred to hold in a configuration. Thus soft constraints may be violated in a configuration. In a configurator implementation, a warning about a violated soft constraint is supposed to be sprung. *Default values* in turn are recommended selections for parts or properties.

5.1.2 FELFERNIG ET AL.

In (2000) Felfernig et al. introduce a conceptualization for presenting configuration knowledge bases on a conceptual level. The conceptualization is extended with functional concepts in (Felfernig et al. 2001; Felfernig & Zanker 2000). The conceptualization has been evaluated with the simplified PC-domain example used in both papers and on real-world problems in the telephone switching systems and automotive industry (Felfernig et al. 2000).

The main concepts of Felfernig et al.'s (2000; 2001) conceptualization are component, resource, function, and port type. A *component type* represents a part the final product can be built of. A component can be characterized with *attributes* that have a specified *domain of possible values*. The definition of function type is not completely clear from (Felfernig et al. 2001) and (Felfernig & Zanker 2000). However, the following aims to capture the meaning of the concept. A *function type* represents functionality the product can provide and can be offered to and selected by a customer. The distinction to a component is that components represent the parts the product is built of and functions specify the purposes of the product (Felfernig & Zanker 2000). A function type can be characterized with attributes similarly as component types.

Both the component and function types can be organized in *aggregation* hierarchies that are represented with *part-of* structures. The part-of relation includes a *multiplicity* that specifies the range of how many subparts an aggregate can consist of. Further, the component and function types with similar structures can be arranged in *generalization* hierarchies. In the generalization hierarchy, the subtype *inherits* the attributes, ports, and constraints of its supertype. Felfernig et al. (2000) do not allow multiple inheritance in order to keep model semantics more comprehensible. Further, only one of the subtypes can be instantiated in a configuration. Therefore, generalization represents configuration choices also.

Felfernig et al. (2000) define a *resource type* as something that is produced by some component (function) types and consumed by others in specified quantities. The produced and consumed resources must be *balanced*, i.e. consumption of a resource must not exceed the production of the resource. The *topology*, i.e. how the components are interconnected, is modeled with port types. A *port type* represents a connection point of a component. A port can be connected to exactly one other port. A port type has a *multiplicity* to define how many connections to the port can be made. The actual connection is modeled with a *connected-with* relation. A connected-with relation can have multiplicities 1..1 (mandatory connection) and 0..1 (optional connection) attached to it.

The conceptualization also includes concepts for two types of constraints. A *requires* relation can be modeled between two component types or two function types. A requires relation between two types (say A, B) means that the existence of an instance of the other type (A) requires the existence of an instance of the other type (B) in the relation. The requires relation is asymmetric. If an *incompatible* relation is modeled between two component types or two function types then instances of both of the types in the relation cannot exist in a configuration. Additional constraints that cannot be modeled with concepts presented above can be modeled with a constraint language suited for the purpose.

5.2 BAIDA ET AL.

5.2.1 GENERAL

The conceptualization of Baida et al. (Baida et al. 2003a; 2003b; 2003c; 2004a; 2004b; Akkermans et al. 2004, this full list of references is omitted later on for brevity) is service-oriented, considers the customer-perspective, and aims to facilitate the definition and configuration of services with a component-based approach. Baida et al.'s conceptualization has been developed in an IST project called OBELIX: Ontology-Based ELectronic Integration of CompleX Products and Value Chains[3].

Baida et al.'s conceptualization aims to facilitate the configuration of services in general. Thus it is not focused on any single domain. Although the research has been done in information systems field it discusses general service literature at length. With the conceptualization Baida et al. aim to facilitate service configuration by service personnel or by customers themselves, possibly online (Baida et al. 2003a) in a Semantic Web environment (Baida et al. 2003b). For configuration implementation purposes the

[3] OBELIX homepage: http://obelix.e3value.com

conceptualization is mapped to a separate configuration task conceptualization (Baida et al. 2003a). Baida et al. provide in (2003a) a case study using the conceptualization to model hosting a meeting service and in (2004a) to a real-world case of modeling a service where a Norwegian energy company combines its electricity supply with other services. The conceptualization is supported with a tool for graphical modeling of services, a configuration tool, and another tool for analyzing the financial attractiveness of the configuration results (Akkermans et al. 2004).

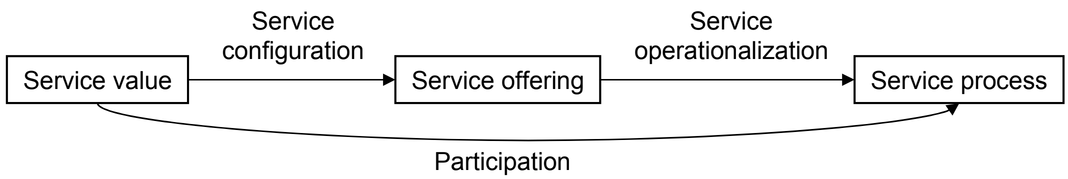

Figure 14 High-level viewpoints of Baida et al.'s conceptualization, adapted from (Akkermans et al. 2004)

5.2.2 *High Level Viewpoints*

The conceptualization incorporates three high level viewpoints: the service value, service offering, and service process perspectives, see Figure 14 and Figure 15. The *service value* perspective describes the service from a customer viewpoint. The *service offering* perspective in turn describes the service from a supplier viewpoint. The *service process* perspective describes how the service offering is put into operation (Akkermans et al. 2004). There are three relationships between the viewpoints in Figure 14. The *service configuration* relationship is there to represent the translation of the requested service value to the service offerings. The service process is the *operationalization* of the service offering hence the relationship. *Customer participation* is common in the service production process in services.

5.2.3 *Concepts and Relations*

Service value perspective: The *service value* perspective describes the service from a customer viewpoint (Akkermans et al. 2004), see Figure 15 (A). It expresses the customer needs and demands, quality of the service sought, and also the sacrifices the customer is willing to give in order to acquire such a service. Akkermans et al. do not present clear definitions for the concepts in the service value perspective. Further, in (Baida et al. 2003c, pp. 68) they mention that their tool implementation of the conceptualization differs from the visualizations in (Baida et al. 2003c; Akkermans et al. 2004) and that the implementation is the correct one. The difference in the value perspective is that the implementation includes the concepts *need* and *want* in addition to the *demand* concept present in the visualizations, see Figure 15 (A). In (Baida et al. 2003c) the need, want, and demand are explained further following business literature[4]. A human *need* is a state of felt deprivation of some basic satisfaction. The *wants* are desires for specific satisfiers of the deeper needs. The *demands* are wants for specific products backed by an ability and willingness to buy them. Example: feel safe (need); worldwide payment facilities (want); credit card service (demand).

Service quality is an aggregation of customer-defined quality requirements, related to set of quality criteria Baida et al. have derived from the general service literature. An example of a possible quality criterion is the star ratings for hotels. A *sacrifice* is something a customer is willing to give in return for the service. It can be both financial, i.e. *price*, and non-financial. Some sacrifices are related to maintaining the business relationship with the service supplier. Such *relationship costs* can be of three types (Baida et al. follow Grönroos 2000): *direct* like investments in office space, *indirect* e.g. the time customer spends in maintaining the relationship, and *psychological* like when a customer feels the service supplier cannot be trusted. Even if a *customer* is included in the service value perspective Baida et al. seem not to indicate that customer should be modeled in any way other than through customer demands.

Service offering perspective: The *service offering* perspective describes the supply-side viewpoint to the service, see Figure 15 (B). The main concept in the perspective is service element. A *service element* represents what a supplier offers to its customers. Service elements describe what the general service literature sees as a service i.e. a business performance of often intangible nature (Akkermans et al. 2004; Baida et al. 2004a). A service element can be decomposed to smaller service elements; the smallest ones are called elementary service elements, see Figure 15 (B). An *elementary service element* must be something that can be offered to customers separately, possibly by different suppliers. A *supplier* supplies an elementary service element. The supplier is included in the conceptualization to facilitate modeling service production where elements provided by different suppliers can be

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[4] Kotler, P. 1988, *Marketing Management, Analysis, Planning, Implementation, and Control*, 6th Ed., Prentice Hall, Englewood Cliffs, NJ, 1988

combined to a single service offered to customers. Baida et al. give service elements roles from a supplier's viewpoint following the general service literature. A service element may be core, supporting, or enhancing. A *core service* is the main business of the supplier. A *supporting service* is necessary for the consumption of a core service. Without the supporting service core service consumption is not possible. An *enhancing service* improves a core service by adding value to it. The core service can be consumed without the enhancing service. Neither supporting nor enhancing services can be offered to the customers independently of a core service.

Another important concept in the service offering perspective is a resource. A *resource* is either a necessary pre-requisite for the provisioning of a service element i.e. a *service input* or a result of the provisioning of a service element i.e. a *service outcome*. A service outcome often represents a customer benefit from the service element (Akkermans et al. 2004; Baida et al. 2004a). The resources can be of different types (see Figure 15 (D)): *physical goods*, *human resources*, *monetary resources*, *information resources* (e.g. customer information), *capability resources* (the ability to do something), *experience resources* (e.g. the fun of going to Disneyland), and *state-change resources* (e.g. a haircut results in a state-change).

A *service bundle* is a set of service elements offered together, possibly by multiple suppliers. Reasons for bundling service elements is that they are somehow related to each other (Baida et al. 2004a). Bundling is more a choice made by the supplier rather than a forced decision. Bundling is recursive: any service bundle is a service element (Akkermans et al. 2004). A *service offering* is a set of one or more service elements and service outcomes. It is similar to service bundle in a sense that it can be offered to customers as well. However, service offering can contain service outcomes whereas a service bundle cannot. The reason for including the service offering concept is that customers may want to also assess the service based on its outcomes (Baida et al. 2003c).

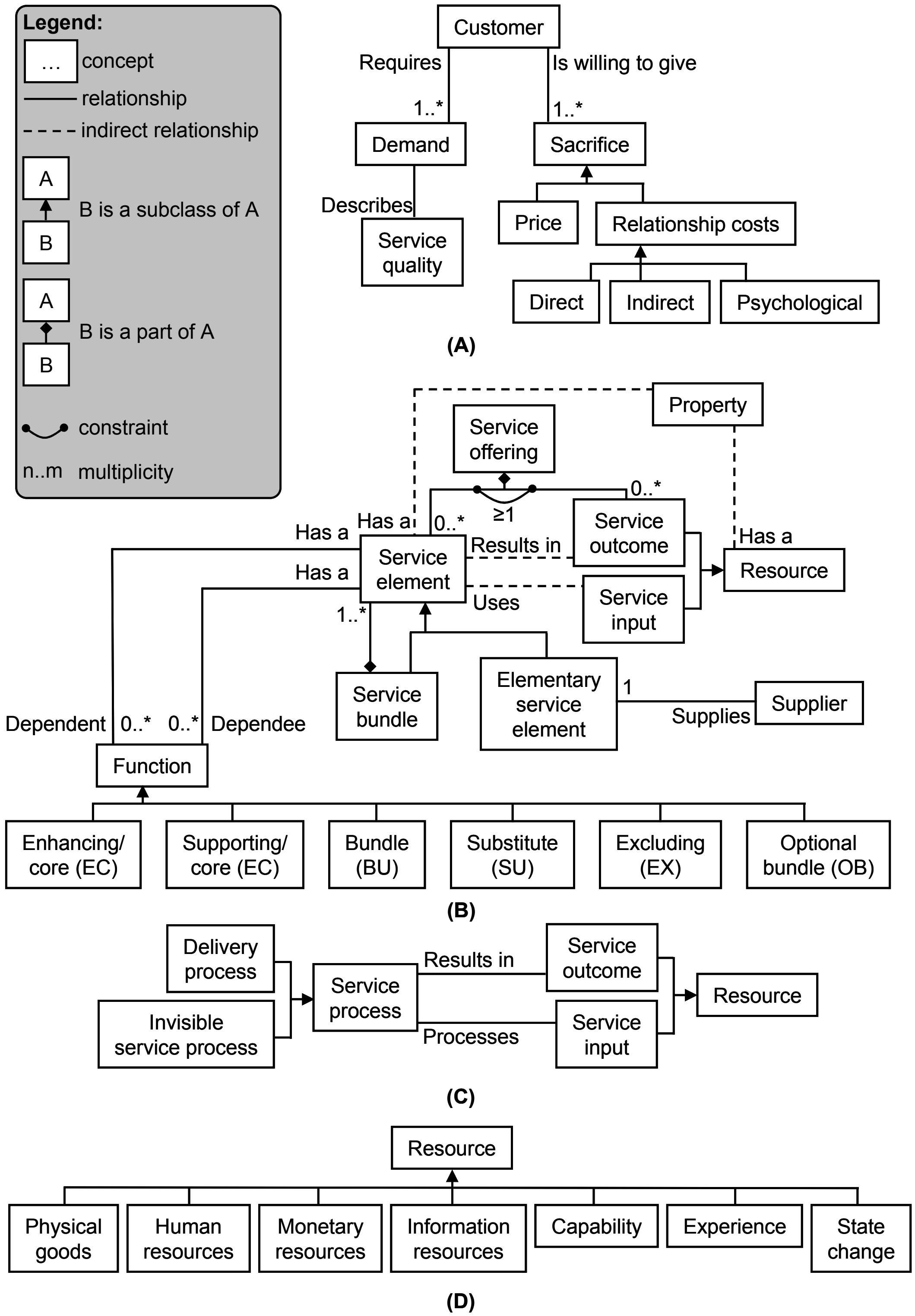

Figure 15 A) Service value perspective B) Service offering perspective C) Service process perspective and D) Resource types of Baida et al.'s conceptualization, adapted from (Akkermans et al. 2004; Baida et al. 2003c)

A service element may have ports, properties, and constraints. A *port* is either an input port or outcome port. The ports define the types of resources that are either pre-requisites for the provisioning of the service element or results from it. A service element cannot be provisioned unless all the required inputs are available. A service element results in availability of all the outcome resources. The set of input ports is called an *input interface* and the set of outcome ports an *outcome interface* (Akkermans et al. 2004; Baida et al. 2004a).

A service element may have properties, often referred to as attributes or parameters (Baida et al. 2003a). There are three general types of properties: quality, productivity, and sacrifice; other properties may be defined too if the modeled domain requires so. However, Baida et al. do not discuss how these domain-specific properties should be defined. The *quality* property is either process or product quality. Baida et al. do not give any other definitions for properties. However judging from the case examples (Baida et al. 2003a; 2004a) it seems that the values a quality property (or any other property) can possibly have are defined per service element. *Productivity* describes the rate of service production. *Sacrifice* is either price or relationship costs, as explained earlier. The price of a service can be defined as constant and also by function to calculate the actual price. For example, the price of two elements may be lower if they are bundled. A *constraint* is a description that limits the permissible values of properties of a service element. It may refer to properties, resources, ports, interfaces, or relationships between resources.

The resources can have properties and constraints as well (Baida et al. 2003a). The resources have the general properties quality, productivity, and possible domain-specific ones just as service elements. A resource can also have a property *state* that is used to describe the actual change in state from something to another state. For example, a change in state for a room resource from available to reserved. The state-change property of service elements is used differently. It describes that a change in state happens.

The resources can have two other properties, sharability and compositeness. *Sharability* means that the resource can be consumed multiple times. *Compositeness* means multiple resources of the same type can be modeled as one resource. Two resources are *identical* if and only if they have the same set of properties, the properties have the same values, and their constraints are identical. The connection between an outcome port and an input port of service elements is possible only if the respective resources defined by the ports are identical.

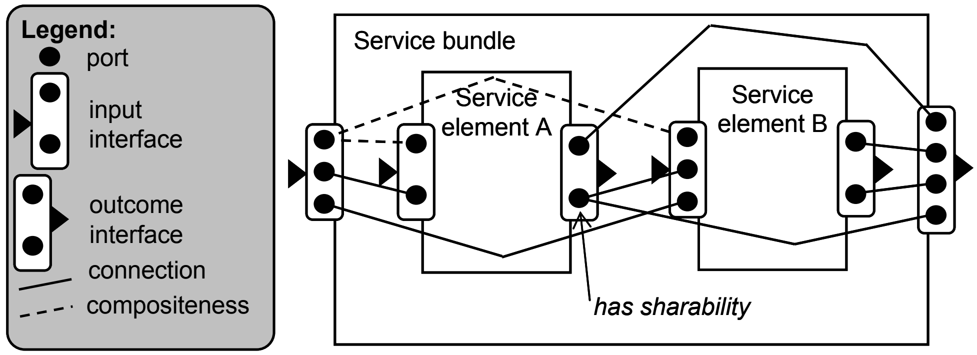

Figure 16 Service bundling, adapted from (Akkermans et al. 2004; Baida et al. 2003c)

When combining service elements to service bundles the input and outcome interfaces of the bundle are defined in the following way: the input interface of the bundle is identical to the union of the input interfaces of the service elements in the bundle. The outcome interface of the bundle is defined respectively. The resources that are consumed by input ports of the service elements inside the bundle are not included in the outcome interface of the bundle. Respectively the input ports that are provided by the outcome ports inside the bundle are not included in the input interface of the bundle. However, an outcome port resource with the sharability property is included in the outcome interface of the bundle even if it is consumed inside the bundle. Further, the input ports of the same type having the compositeness property can be combined into one resource in the input interface of the bundle (Akkermans et al. 2004; Baida et al. 2004a). Figure 16 illustrates service bundling.

A function is a relationship between two service elements. It constrains how these two elements can be bundled. The rationale for functions is usually business-related. A function receives two arguments of service elements, a *dependee* (A) and a *dependent* (B). Baida et al. (2004a) define six functions[5]. In the following, *Output:* is used identically to (Baida et al. 2004a) to denote the possible ways in which A and B can included in a configuration.

Core/enhancing (A, B): B in someway enhances A but is not necessary for provisioning of A. Yet, B cannot be offered independently of A. If customer includes A in his

[5] In Baida et al. 2003c they have five functions with definitions of which some differ from the ones presented here. The definitions from 2004a were chosen, as it is a newer and also peer-reviewed publication.

configuration, he is presented with the option of including B as well. A valid configuration can include either A alone or both A and B. *Output:* {A}, {A,B}.

Core/supporting (A, B): B supports the provisioning of A. If a customer includes A in his configuration, he is obliged to include B as well. B cannot be offered independently. An example of supporting services could be billing. *Output:* {A,B}.

Bundled (A, B): If a customer chooses to buy service element A, he has to buy B too. This is otherwise similar to core/supporting but in this case B may be offered independently. The rationale behind bundling is business-related and not if some service is element is necessary for the provisioning of another. *Output:* {A,B}.

OptionalBundle (A, B): Both A and B are offered separately but also as an optional bundle. The rationale may e.g. be a lower price for the customer than if A and B were bought separately. The difference to core/enhancing-function is that B can be offered independently of A. *Output:* {A}, {A,B}.

Substitute (A, B): The benefits presented by A, i.e. service outcomes, are also presented by B. Therefore, B can be bought instead of A. B may possibly offer more benefits. A is not a substitute of B as it necessarily does not offer the same benefits. *Output:* {A}, {B}.

Excluding (A, B): If A is consumed B cannot be. *Output:* {A}

Service process perspective: The service process perspective describes how the service is put into operation. It is visualized in Figure 15 (C). The *service process* represents all the necessary business processes for providing a service element. The *service delivery* is the part of the service process visible to the customers. The customers participate in the service delivery. The *invisible service process* is in turn the part of the service process customers are not exposed to. Baida et al. (2003b; 2003c) state that as their conceptualization is customer-oriented the invisible service process is of secondary importance. The customers may be interested in the results of the invisible service process but probably not in how it is carried out. A service process requires *service inputs* as *resources* to produce its results, the *service outcomes*. The resources are used in both the service offering and service process perspectives. On the offering perspective, the resources describe *what* is offered whereas on the process perspective the resources describe *how* the service is being offered. On the process perspective they are related to the actual service production and consumption and often include the actual means required to produce the service (Baida et al. 2003a). Baida et al. claim that the service process perspective can be captured adequately with existing process modeling approaches (Akkermans et al. 2004; Baida et al. 2003a) and that customers are probably only interested in the process results (Baida et al. 2003c). Therefore Baida et al. do not discuss process perspective in detail (Akkermans et al. 2004; Baida et al. 2003a; 2003c). Baida et al. seem to base this argument on their own judgement.

Dependencies between the perspectives: Baida et al. do not give details on the dependencies between the perspectives. However, some can be found.

- Service process perspective – service offering perspective: a *service element* is *produced by* a business processes described by a *service process*.

- Service value perspective – service offering perspective: in (2004b) Baida et al. describe the following linkage between the perspectives: service element/service outcome B can satisfy demand A. These links are modeled in the form *'IF demand B THEN service element/outcome A'*. A demand can be satisfied by multiple service elements/outcomes. In addition, a service element/outcome can satisfy multiple demands. However, apparently there is no way to model a situation where multiple service elements/outcomes would be required to satisfy one demand fully.

5.3 Models Specific to a Service Domain

This section discusses models that have been developed for certain service domains.

5.3.1 Dausch & Hsu

Dausch & Hsu (2003a; 2003b, b is a longer version of the same article) describe a reference model developed to support defining and even mass-customizing service agreements for heavy industrial equipment. The model is supposed to serve as a starting point for the design of the overall service platform and guide the definition of individual service agreements. Dausch & Hsu (2003a) created the model in a case study with General Electric. An overview of the reference model is shown in Figure 17. Dausch & Hsu regrettably do not give concrete examples of the model's usage in (2003a; 2003b).

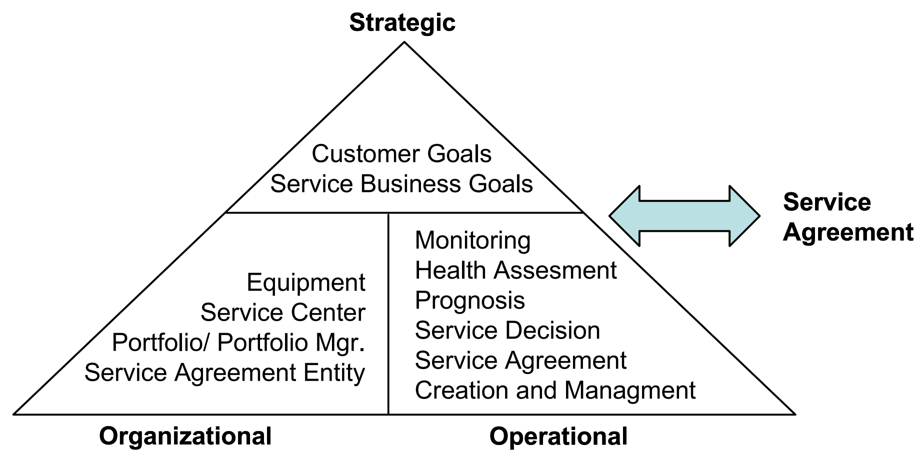

Figure 17 Overview of Dausch & Hsu's reference model (Dausch & Hsu 2003a)

The model is divided to three perspectives: strategic, organizational, and operational of which the latter two form the tactical tier and the former the strategic tier. The *strategic tier* includes the basic *goals of both the customer and provider* and the *linkages between the goals and* the service delivery issues *(processes)* that reside on the *tactical tier*. The *customer goals* on the strategic perspective are organized in hierarchies. The goals represent the subset of all customer goals that are somehow depend on the heavy equipment the customer owns and may be influenced or contributed by the service provider. The goals included in the hierarchy are e.g. guarantee availability, comply with insurer, reduce operating cost, etc. The higher-level goals are broken down to lower-level goals. The goals important for the service provider and equipment manufacturer are identified in a *service business goal hierarchy*. Examples of the goals include increase revenue, guarantee availability, and optimize operation. Dausch & Hsu (2003a) state these goals most likely have to be customized for individual companies. Both the customer and provider goals are then linked to *service elements* that represent parts of the *service agreement*. This enables identifying the service elements that should be included in a service agreement to address the goals customer and provider find necessary.

The *organizational* section in the tactical tier describes the important entities of the service delivery business and the relationships between them. An entity view focusing on the service agreement is shown in Figure 18. Such views are intended to guide management on how to organize service organization and what roles and behaviors are needed. Dausch & Hsu (2003a) state that the service agreement can be pieced to service elements that include e.g. the service description, service context, and financial elements like pricing. Dausch & Hsu do not describe the contents of service agreements in more detail in (2003a; 2003b).

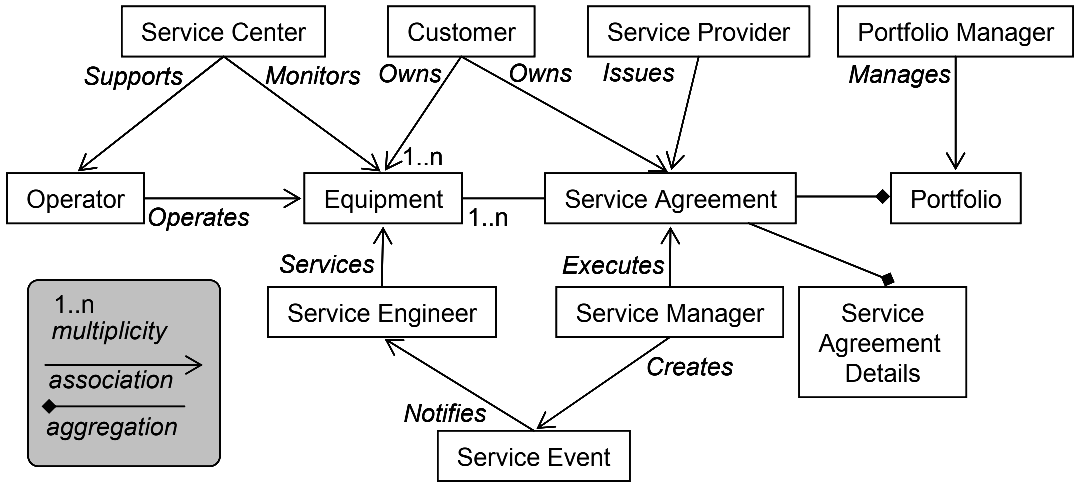

Figure 18 An entity view focusing on the service agreement, adapted from (Dausch & Hsu 2003a)

On the tactical tier, the operational perspective provides views to describe the different processes necessary for the service delivery in heavy equipment services (Dausch & Hsu 2003a). The model consists of *processes, tasks, inputs, outputs, mechanisms, constraints* and *associated goals*. The processes and tasks describe the decomposition of processes into tasks. The inputs and outputs are the requirements and results of processes respectively. The mechanisms describe the resources required to carry out the process. A process may be constrained by rules, regulations, finances, etc. The following six business processes are included in the model: *monitoring, health assessment, prognosis, service decision, service agreement creation,* and *service agreement management*. Because most of them are related to the chosen domain and this thesis focuses on the customer-perspective the processes are not discussed further here.

5.3.2 MEIER ET AL.

Meier et al. (2002) do not provide a well-defined conceptualization. However, they discuss modular services in the domain of industrial services, like Dausch & Hsu's reference model described in 5.3.1 do, which is why their contribution is mentioned here, albeit briefly.

Meier et al.'s (2002) approach aims to develop standard service modules that can be combined in various ways using a to-be-developed service configurator. Their approach includes a catalog of standardized modules of customer requirements and supplier's repertoire. The *requirements are met by the supplier's modules*. Basically, the modules are processes. The modules can have process-oriented and aggregation-oriented attributes. The process-oriented ones contain information about the possibilities to link different modules and what modules are necessary. The aggregation-oriented attributes include expected costs and required staff and their qualifications. In short summary, Meier et al.'s approach aims to define generic service modules for the industrial services domain. The *modules are then combined in various ways to offer customer-specific services*. The approach seems to be more concerned on the process perspective to services, rather than customers' view.

5.3.3 BÖHMANN ET AL.

Böhmann et al. (2003) propose an approach of using modular service architectures as a way to improve the customization of IT services. They do not provide a well-defined conceptualization. However, Böhmann et al.'s (2003) approach is an example of modeling services in a modular way in another domain. Their approach has been developed in a case study with a leading German application hosting service company in the ERP market.

Böhmann et al. (2003) suggest that management and development of a complex service is easier if it is decomposed to units. For the units, the role of each unit in the service has to be precisely defined. Often the division results in a nested *hierarchy of decomposition*. Böhmann et al. (2003) suggest that the units should be loosely coupled, the information not relevant for the interplay of units should be hidden and the interplay be based on standardized interfaces. A *service architecture* is an expression of agreement about the interfaces that is forced through service development and operations. It is an integration framework for service modules through which they can be combined.

Böhmann et al. (2003) discuss the information that needs to be specified about service modules. A *service module* description needs to include a specification of the actual services the module provides. Such a specification should list the service features and options, like levels of system availability. The options are used to further customize the service module to match customer requirements. Also, the *services the customer has to provide for successful service delivery must be listed*. Further, the possible choices for pricing and billing should be included in the module description. To ensure a consistent customer experience, the customer interaction possibly required should be defined per module. Otherwise, the independence of modules may lead to insufficient interaction between them in terms of consistent customer experience. The interaction of processes related to modules has to be specified too.

5.3.4 *WIMMER ET AL.*

Wimmer et al. (2003) propose an object-oriented model for modeling financial services in a mass customization setting. They argue that financial services are based on a contractual agreement between the provider and customer. The agreement describes services and features related to the financial product. Wimmer et al. (2003) state that in addition to the contractual nature of financial services the following issues have to be considered when modeling financial services: *intangibility*, importance of *external factors*, *production-to-order*, and modeling of relevant *customer attributes*. In financial services, the production begins only after a customer has initiated the transaction and the customer attributes often important e.g. for risk-oriented pricing and selection.

An overview of Wimmer et al.'s (2003) meta-model is shown in Figure 19. The meta-model defines the concepts, their relations, and rules how to combine them. These are then used to model real products. The meta-classes allow company-specific customization of the product model. A *product component* describes an essential part of the product or the product itself. A product component is assigned to a *product component type* (e.g. product, product component). It is possible to compose new product components using *relations* and existing product components. The *relation types* describe what kind the relations are, *e.g. "is-a" generalization or "is-part-of" aggregation*. Further dependencies between product components can be modeled with *relation rules* that are defined in the *relation rule type* meta-classes, e.g. *"interacts with"* or *"exclusion"*. The product components are further characterized by attributes and functions. An *attribute assignment* describes the assignment of an *attribute group* or an *attribute* to a product component in the context of a *role* and a *view* (e.g. contract view). An attribute describes an elementary attribute that is a part of a product (e.g. name, nominal interest). An *attribute rule* defines the possible values of an attribute. An attribute group bundles attributes or attribute groups to bigger units. These units, like "person", are necessary for the assignment of roles (e.g. account holder is a possible role). A *function assignment* describes the assignment of *functions* to a product component in the context of a view. A function describes functions of product component that operate on attributes. A *function rule* describes a condition that must hold, e.g. "person must be an adult". A function group bundles functions or function groups to a bigger unit. The views allow supplying different processes like sales or after sales services with relevant product information.

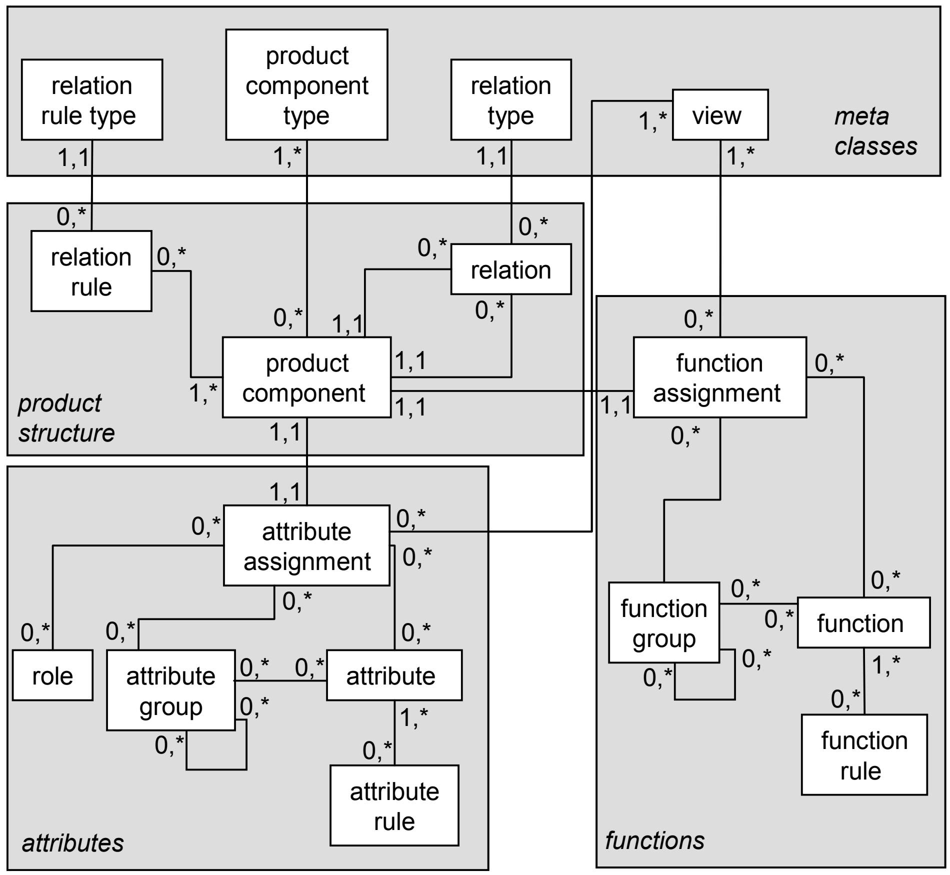

Figure 19 Wimmer et al.'s meta-model, (Wimmer et al. 2003)

5.3.5 WINTER

Winter (2001) proposes a simple model for configuration of financial services. It has a three-level hierarchy. An overview of Winter's model is shown in Figure 20. Winter's (2001) model in Figure 20 is drawn based on the text of his paper. He does not define a model himself. On the highest level is a *product type*. A product type has a set of *attributes*. An attribute in turn has a set of *attribute values* that form the third and lowest level. An attribute may be *compulsory* or *optional*. An attribute may be either *single-valued* (i.e. its attribute values are exclusive, only one can be chosen) or *multi-valued*. Further, attribute values of different attributes may have *inclusion* or *exclusion* dependencies between them. A *product variant* is described with the chosen attribute values of the attributes of a product type. Winter (2001) also mentions that adding additional constraints, tables for maintaining feasible attribute value combinations, and integration of individual calculation routines is possible. However, Winter does not elaborate these concepts further in (2001) although the focus of the paper (Winter 2001) admittedly is not to describe the model in detail.

Winter (2001) discusses some specialties in configuration of financial services. Winter (2001) stresses the *importance of including customer properties in the configuration*. Furthermore, he argues that more constraints have to be presented than in configuration of mechanical products. This results from the fact that financial services reflect regulations, pricing rules, customer properties, and risk properties.

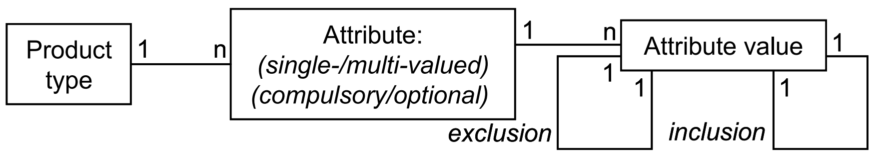

Figure 20 An overview of Winter's model, drawn based on (Winter 2001)

5.4 SERVICE DEVELOPMENT MODELS

This section discusses some models from the service development and design field that have been touched upon in 4.3.

5.4.1 BULLINGER ET AL.

Bullinger et al.'s (2003) approach is geared towards service development. However, they argue that the modular approach they also adopt would be beneficial for situations where a service offering has to be regularly adapted to specific customer wants. Their model is shown in Figure 21. Bullinger et al. (2003) do not give examples of the model's usage. The core concept in the model is a *service activity*. The activities can be arranged in a hierarchical (vertical) arrangement as a product model that describes *what the services include* i.e. the *outcomes* of a service and in a value-adding (horizontal) arrangement as a process model that describes the service delivery *process* i.e. *how the outcomes of the service are achieved*. The activities can be bundled and offered to customers as service products. The *resources* of different types describe what is necessary to perform the services. The service products are offered to customers of a customer segment via a sales channel. Bullinger et al. (2003) use Unified Modeling Language (UML) to depict their model and argue that UML can be used to model services as well.

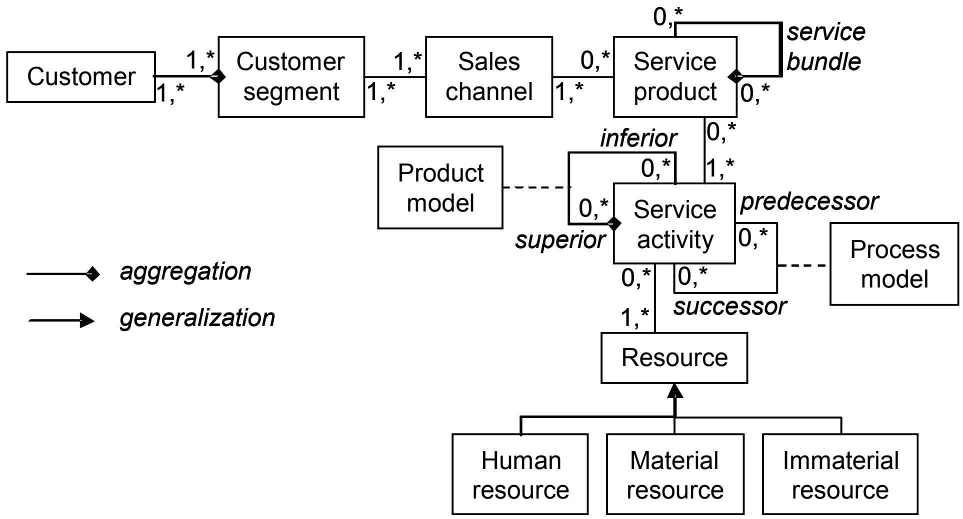

Figure 21 Bullinger et al.'s model, adapted from (Bullinger et al. 2003, in UML with the differences in notation shown in the figure)

5.4.2 SCHEER ET AL.

Scheer et al.'s (2004) goal is to define a design approach for services that allows the description of service in *output*, *process*, and *resources* dimensions and the dependencies between the modeling dimensions, similarly as Bullinger et al. (2003). However, Scheer et al.'s approach seems to be broader. Further, Scheer et al's model seems to be used in a tool implementation developed in an academic research project. The purpose of Computer Aided Service Engineering Tool (CASET)[6] is to help service development. The focus of this discussion is on the models Scheer et al. propose for describing the output dimension. The process and resources dimension models are only discussed on issues interesting from the customer perspective.

On the meta-level of Scheer et al.'s model, the models of certain types consist of objects of different types. Their metal-level model is shown in Figure 22. The object types can have attributes and relationships between them. To model the different semantic meanings of the relationships between the object types, it is possible to define different relationship types.

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[6] CASET, see www.caset.de.

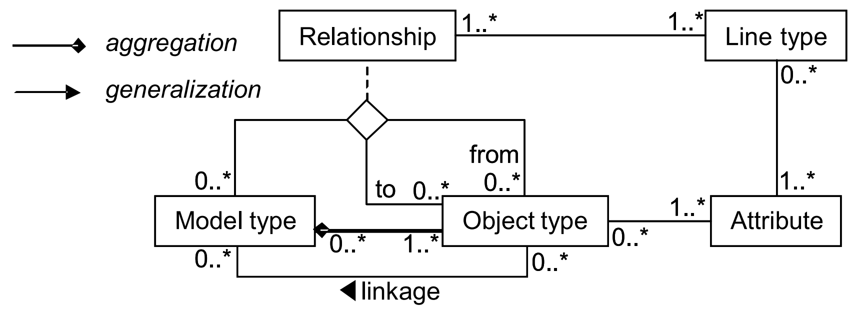

Figure 22 Scheer et al.'s meta-level model, (adapted from Scheer et al. 2004, in UML with the differences in notation shown in the figure)

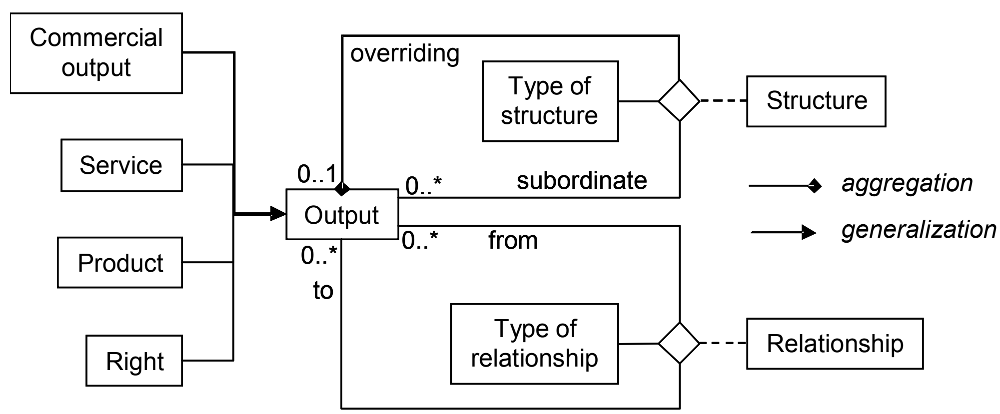

Figure 23 Scheer et al.'s Product hierarchical structure meta-model, (adapted from Scheer et al. 2004, in UML with the differences in notation shown in the figure)

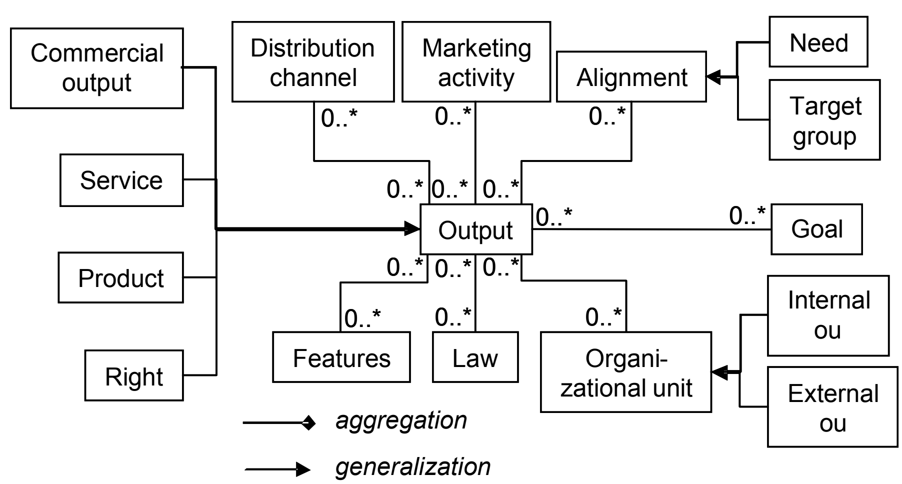

Figure 24 Scheer et al.'s Output allocation diagram meta-model, (adapted from Scheer et al. 2004, in UML with the differences in notation shown in the figure)

The outputs of the service are in the core of the product dimension models. Figure 23 shows the meta-model of a product hierarchical structure. An aggregation structure, which is hierarchical, consists of outputs of different types (commercial, service, product, or right). One can define multiple types of structures. Further, outputs can be linked in non-hierarchical ways with different types of relationships. The product hierarchical structure models can be used for internal and external purposes. An external structure model should describe the situation- and customer-specific commercial services by using standard components. In turn, an internal model should describe the entire company service product portfolio and for example can be used for measurement purposes.

The other product dimension model, i.e. the output allocation diagram, is shown in Figure 24. The output allocation diagram describes different issues involved with the outputs. An *output may be aligned for certain needs* or target (customer) groups. Further, marketing activities and the distribution channel used for an output can be defined as well. The relevant laws and the organizational unit responsible for the output can be defined also. An output maybe linked to several goals and features. Regrettably Scheer et al. do not explain goals or features further in (Scheer et al. 2004).

Scheer et al's (2004) approach has two models for describing the process dimension. The process module chain describes the process on a high aggregation level as encapsulated self-contained process parts, i.e. the process modules, whereas the event-driven process chain describes the steps of the service process in detail. In fact, the process modules in the higher level process module chain enclose a detailed event-driven process chain illustration of the steps needed to deliver the process module. The process modules can be defined in successive arrangements and also logical relationships that are used to describe the *alternative and parallel running processes*. Further, a process module may be linked to information about the *extent of customer integration* in the module, possible sources of error, and environment objects. The line of visibility is used to depict whether a process module is performed by the customer, in the visibility of the customer (onstage) or not (backstage).

The resource dimension is described by several models in the Scheer et al's (2004) approach. From the customer perspective, it is interesting that the *customer can be a necessary resource for certain processes*. The resource dimension is not relevant from customer perspective in other ways.

5.4.3 MA ET AL.

Ma et al. (2002) present a quite detailed service design technique that concentrates on the customer and the customer process flow in the service system. Ma et al. (2002) present an example of their model in context of gas delivery. Their generic model is shown in Figure 25. The approach takes the view that the customer's service experience is actually the service product. It argues that the customers, customer process flow, and a set of both activity inputs and outcomes define the service product, i.e. the *customer service experience*. The *customer* is a consumption unit the experience corresponds to. A customer may be an individual, a group of people, or an organization. The customers can be described with attributes, e.g. age, gender, profession, or with their consumption tendencies like economizing, ethical, and convenience.

The *customer process flow* describes how customers participate in the process during service delivery. It is a network of customer activities that take a set of inputs and generate outcomes. The process flow between different activities is in turn described with *execution transitions* that refer to temporal and logical relationships between executions of different customer activities. A *customer activity* refers to how the customers operate during a service experience. It can be characterized with information like processing time, frequency, execution conditions, activity scripts, etc. The customer activities can be decomposed to activities of more detailed descriptions.

The *activity inputs* describe what customers put in or process during a customer activity. The *activity outcomes* indicate the (expected) results brought about by a customer activity. The experience of the outcomes form the customer perceived service benefit. The *inanimate physical evidence* describe material objects that customers may utilize during the process flow. The *events* denote a change in state or other significant occurrence that has a location in time and space. The *contact employees* describe the service personnel that have contacts with the customers. The contact employees can be characterized in terms of their desired properties. The *fellow customer environment* refers to the presence of other customer during the customer process flow that may affect the service experience. Ma et al. (2002) describe their model in more detail in their paper, including the choices made in modeling the variable process paths.

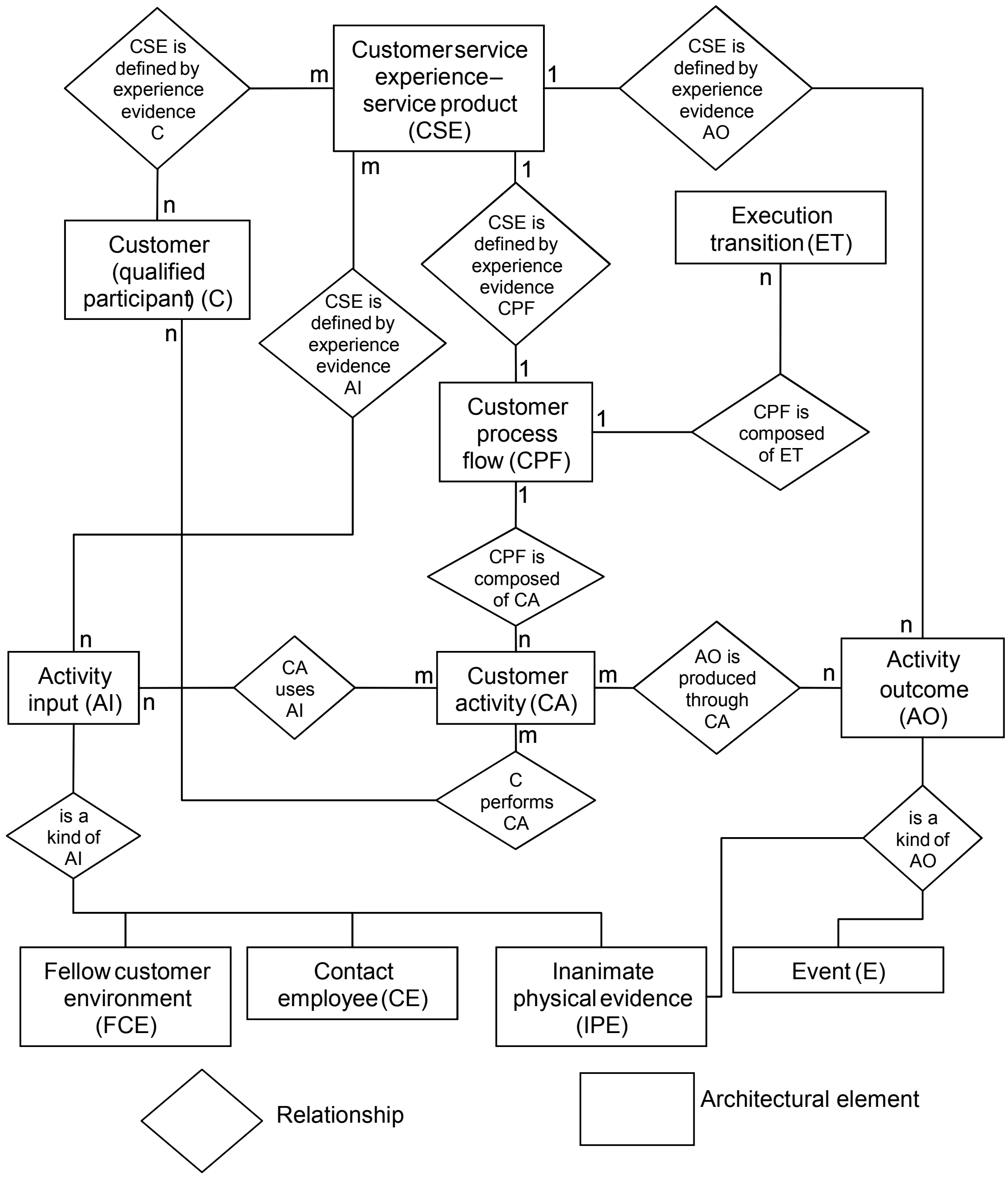

Figure 25 Ma et al's generic model of service products, adapted from (Ma et al. 2002)

5.5 Comparison

This section provides a comparative discussion of the existing modeling approaches presented earlier. The comparison is divided to two viewpoints: on the one hand on what is modeled, captured in the approach, see 5.5.1, and on the other hand what modeling mechanisms are used in the models, see 5.5.2.

5.5.1 *Modeled Issues*

The discussion here follows the issues found to be possibly relevant for configurable services based on service literature, see 4.5 and Figure 13.

Customer

None of the approaches provides any specific concepts to capture the customer. However, Wimmer et al. (2003) and Winter (2001) argue that modeling customer characteristics is important in their domains, i.e. financial services, as customer characteristics often influence e.g. risk oriented pricing and customer selection. The customer is present in Baida et al.'s (Baida et al. 2003a; 2003b; 2003c; 2004a; 2004b; Akkermans et al. 2004) model but seems not to be intended to be captured in other ways than through customer needs. Dausch & Hsu (2003a; 2003b) model includes the customer as owner of maintained equipment. Judging from Dausch & Hsu (2003a; 2003b), maintained equipment might affect service agreements and therefore could be relevant for service configuration. Ma et al. (2002) list several attributes that can be used to characterize customers. They also state that a customer may be an individual, a group of people, or an organization.

Needs

The needs describe why a customer would want to buy the service. Comparable issues to customer needs are present is several approaches. Soininen et al. (1998) and Felfernig et al. (2001) both use functions to denote something not part of the product itself but rather benefits resulting from the use of the product or needs satisfied with it. Baida et al. (2003a; 2003b; 2003c) use customer needs, wants, and demands to describe what customers wish to receive from a service. Dausch & Hsu (2003a; 2003b) model goals of both the customer and the company to be met with the service. Meier et al. (2002) list customer requirements to be met with processes. Scheer et al. (2004) have service outputs that are aligned to customer needs they satisfy.

Outcomes

The outcomes meet or satisfy the customer needs and describe what the customer is buying. In product configuration models of Soininen et al. (1998) and Felfernig et al. (2001) functions are implemented by some product characteristics. Modeling the product characteristics is the focus of product configuration and they seem comparable to service outcomes. Baida et al. (Akkermans et al. 2004) have a service offering perspective that describes what a supplier offers to its customers. Dausch & Hsu's (2003a; 2003b) approach includes a service agreement describing e.g. service contents and pricing. Meier et al.'s (2002) approach includes a catalog of supplier modules that are supposed to meet customer requirements. These modules are basically processes, though. Böhmann et al. (2003) have service modules meeting customer requirements. The modules specify among other things the actual services the module provides. Wimmer et al.'s (2003) model aims to capture contractual agreements between the customer and provider. The agreements specify what the customer receives. Winter's (2001) approach captures similar issues as Wimmer et al.'s (2003). Bullinger et al.'s (2003) approach includes a product model part that describes the service contents i.e. the outcomes from service processes. Scheer et al.'s (2004) model has outputs used for modeling service structure.

Process

Services are produced with processes. The product configuration models of Soininen et al. (1998) and Felfernig et al. (2000; 2001) do not include any concepts for modeling processes. Processes are only present in service modeling approaches. In Baida et al. (2003a; 2003b; 2003c), processes are modeled. However, Baida et al. (Akkermans et al. 2004) argue that customers probably are not interested in the actual processes but rather on the process results and hence do not discuss processes in detail. Dausch & Hsu (2003a; 2003b) describe several domain-related specific processes related to maintenance of heavy industrial equipment. Meier et al.'s (2002) approach includes service modules that represent processes. Böhmann et al. (2003) argue customer's participation in processes must be defined to ensure a consistent customer experience. Wimmer et al. (2003) and Winter (2001) both do not model processes. In service development models, like Bullinger et al. (2003), Scheer et al. (2004), and Ma et al. (2002), process is at the core of the approaches. Scheer et al. (2004) and Ma et al. (2002) argue that customer participation in the process should be captured.

Resources

The processes require resources to be successfully carried out. The product configuration models of Soininen et al. (1998) and Felfernig et al. (2000) do model resource production and consumption. However, they do it in a different context and with different aims compared to resource usage of processes. Nevertheless, the resource production and consumption of product configuration models could be useful for process modeling. In Baida et al.'s (2003a; 2003b; 2003c) approach, the process modules result in resources as outputs and use resources as inputs. The precedence of tasks in a process is modeled with resource usage in their approach. Dausch & Hsu (2003a; 2003b) include the resources necessary to carry out a process in their approach. In Meier et al.'s (2002) approach, process modules can have information about e.g. required staff and their qualifications. Böhmann et al. (2003), Wimmer et al. (2003), and Winter (2001) do not model resources. The service development models of Bullinger et al. (2003), Scheer et al. (2004), and Ma et al. (2002) all include resources.

5.5.2 Modeling Mechanisms and Concepts

Six models were chosen for comparison on terms of modeling mechanisms and concepts used, see Table 6 and Table 7. The approaches of Soininen et al. (1998, see also 5.1.1) and Felfernig et al. (2000, see also 5.1.2) were chosen as representatives of product configuration, approaches of Baida et al. (Baida et al. 2003a; 2003b; 2003c; 2004a; 2004b; Akkermans et al. 2004, see also 5.2) and Wimmer et al. (2003, see also 5.3.4) as representatives of service configuration approaches, and finally Scheer et al. (2004, see also 5.4.2) as a representative of service development approach with some variability modeling capabilities. Dausch & Hsu's model (2003a; 2003b) was left out because of its tight focus on heavy equipment maintenance and lack of generalizability. Meier et al. (2002), Böhmann et al. (2003), and Winter (2001) were excluded as none of them define a conceptual model. Scheer et al. (2004) was chosen as a representative of service design models ahead of Bullinger et al. (2003) and Ma et al. (2002) as it is the most extensive and has existing tool support for the model.

Table 6 and Table 7 together summarize the comparison in terms of modeling mechanisms and concepts. The models are compared in the tables along the following dimensions.

- **Problem meant to solve:** Why has the model been developed? What is it used for?
- **Intended domain of use:** What is the intended domain of use? What part of reality the model's concepts are intended to capture?

- **Scientific background:** In what scientific research stream has the model been developed in?
- **Evaluation:** How has the model been evaluated?
- **Main viewpoints:** What are the main viewpoints used to capture the domain?
- **Main concepts:** What are the main concepts used in the model?
- **Generalization:** Does the model allow generalization?
- **Composition:** Does the model support defining of compositional structures? How does it support it?
- **Other relations:** Are there other relations possible between the concepts of the model? What are they?
- **Rules/constrains/other:** Does the model allow definition of constraints or rules? Are there other similar modeling mechanisms? What are they?
- **Customer perspective:** How does the model take the customer perspective into consideration?

The product configuration approaches of Soininen et al. (1998) and Felfernig et al. (2000; 2001) are very similar and seem to provide more variability modeling means than the other models. The other models do not have all of generalization, composition, component parameterization with attributes, topology, resource production and consumption, and freely formed constraints. On the other hand, the service-oriented models have concepts that product configuration approaches do not. Process modeling with successive, parallel, and alternative process modules is possible in Scheer et al. (2004). They also include description of the possible customer participation in the process modules. Baida et al. (2003a; 2003b; 2003c) also model the process. To provide different viewpoints to information in the product model Wimmer et al. (2003) use views and roles attributes are related to. Baida et al. use (2003a; 2003b; 2003c) both service bundles (collection of service elements) and service offerings (collection of service elements and service outcomes) as structural modeling mechanisms.

Table 6 Comparison of Soininen et al., Felfernig et al.

	Soininen et al.	Felfernig et al.
Problem meant to solve	Generalized ontology for product configuration	Presenting configuration knowledge bases on a conceptual level
Intended domain of use	Goods	Goods
Scientific background	Artificial intelligence	Artificial intelligence
Evaluation	Case examples of products modeled	Case examples of products modeled
Main viewpoints	Product structure and functional view to describe features.	Product structure and functional view to describe features.
Main concepts	Component, resource, port, and function type. Types can have attributes, attributes are optional or obligatory, and define their possible values.	Component, resource, port, and function type. Components and functions are characterized with attributes having a domain of possible values.
Generalization	Generalization for types.	Generalization for function and component types.
Composition	Structural hierarchy, with components and their parts, parts are defined through part roles. Functions are broken down to their parts similarly as well.	Aggregation with part-of relations between components and functions.
Other relations	Topology of components, i.e. connections, defined through ports. Resource production and use. Functions are implemented by other concepts, defined with implementation constraints.	Topology, defined with ports and connected-with relations. Resource production and use.
Rules/ constraints/ other	Constraints: conditions that must hold in a valid configuration. Soft constraints: conditions that are preferred to hold in a configuration. Default values: recommended selections.	Requires. Incompatible. Other constraints with a constraint language.
Customer perspective	Argue that functions could be used to describe goods from a non-technical perspective.	Functions describe product functionality, may be used for customer-oriented description but no specific implemented-by relations available.

Table 7 Comparison of Baida et al., Wimmer et al., and Scheer et al.

	Baida et al.	Wimmer et al.	Scheer et al.
Problem meant to solve	Facilitate configuration of services with a component-based approach	Modeling financial services in a mass customization setting	Design and description of services
Intended domain of use	Services	Financial services	Services
Scientific background	Information systems	Information systems/ mass customization (?)	Service development/ information systems
Evaluation	Case examples of modeled service	Case example	No examples

	Baida et al.	Wimmer et al.	Scheer et al.
Main viewpoints	Service value, roughly the customer needs Service offering, the service product. Service process, the process of delivery.	Financial service product structure.	Divide service design to product/output, process, and resource dimensions. *Here focus on product dimension.*
Main concepts	*Value* viewpoint: need, demand, want, service quality, sacrifice. Offering viewpoint: service element, supplier, resource, service input and outcome, service bundle, service offering. Service element has ports, and properties. Process viewpoint: service process, service outcome and input, resource.	Product component, attribute, attribute group, attribute assignment, function, function group, function assignment, role, view. An attribute assignment assigns an attribute or attribute group to a component in the context of a role and a view. An attribute rule defines an attribute's possible values.	Objects, relations between them, and objects' attributes. Output, need, target group, goal, process modules and others.
Generalization	No	None "ready" but possible to add and suggests defining generalization between components.	No?
Composition	*Value viewpoint:* not clear. *Offering viewpoint:* Service elements can be combined in service bundles. Service elements and service outcomes can be combined in service offerings.	None "ready" but possible to add and suggests defining aggregation between components.	Aggregation through overriding-subordinate relations between outputs. Process modules can encapsulate more detailed modules.

	Baida et al.	Wimmer et al.	Scheer et al.
Other relations	*Offering viewpoint:* Service elements have service inputs as pre-requisites for their provision and produce service outcomes that can be inputs for other elements *Process viewpoint:* Service process requires service inputs as resources to produce its service outcomes *Between viewpoints:* Service element is produced by business process described by a service process. Service element can satisfy demand – a demand may be satisfied by multiple elements and an element may satisfy multiple demands.	Relations definable by the modeler. Attributes are defined in the context of a role and a view. Functions are defined in the context of a view. Views allow supplying relevant information from different viewpoints.	Aggregation through overriding-subordinate relations between outputs. Outputs also can be related to certain goals aligned to needs or (customer) target groups. Process modules can be organized as successive, parallel, alternative.
Rules/ constraints/ other	*Value viewpoint*: No? *Offering viewpoint:* The inputs and outcomes of a service bundle are the union of the respective inputs and outcomes of the elements of the bundle. Functions are fixed rules that restrict how two service elements can be bundled. Constraints limit the permissible values of properties of service elements or resources *Process viewpoint:* No?	A function rule defines a condition that must hold. Functions operate on attributes.	Possible to define non-hierarchical relations.

	Baida et al.	Wimmer et al.	Scheer et al.
Customer perspective	Service value viewpoint aims to describe service from a customer perspective. Demands are satisfied with service elements.	No specific concepts but stress the importance of modeling customer attributes in a product model.	Outputs aligned to needs, target groups, and goals. Process module may contain information about required customer integration.

5.6 ANALYSIS

This section briefly analyses the above comparison and aims to recognize relevant issues and mechanisms required to model configurable services.

In terms of variability modeling mechanisms, it seems the current product configuration approaches are sufficient for modeling configurable services as well, judging from the dimensions composition, generalization, and rules/constraints/other. On those dimensions, the product configuration conceptualizations offer similar mechanisms as the service-oriented ones. Generalization should be included as it helps to maintain configuration knowledge (see 5.1.1), an important challenge in product configuration (see 3.3). However, the product configuration approaches fall short on a conceptual level. They do not provide specific concepts for modeling the process, customers' participation in it, or the customer characteristics. All are issues identified in the service-oriented approaches. Dausch & Hsu's (2003a; 2003b) maintenance services specific approach includes the maintained equipment that could influence the service agreements as well. The customer perspective is present in many of the models in the form of concepts aiming to capture customer requirements, needs, or demands.

6 CASE COMPANIES

This section briefly describes the case companies and their services. The main case company, Tapiola group is discussed in more detail as its services are used to evaluate the feasibility of the conceptual model developed in this study. The other company is included in order to recognize issues relevant for modeling configurable services from another domain as well. The information presented about the case companies is based on the research material, mostly analysis company material and interviews, gathered in the ConSerWe-project, see 1.3.2.

6.1 TAPIOLA GROUP

Tapiola Group[7] is a prominent group of Finnish mutual insurance and financial services companies, holding the third biggest share of insurance markets in Finland (Vakuutusyhtiöiden Keskusliitto 2005). Tapiola offers insurance, financial, and banking services for over one million customers that consist of e.g. individuals, companies, farms. Thus, the customer needs Tapiola has to meet vary greatly. In this study the focus is on insurance services for individuals. Insurance contracts in general are deemed complex and are hence an apt case for evaluating the feasibility of the conceptualization developed in this thesis.

In the following, Tapiola's insurance services are considered from the viewpoints of customer, needs, outcomes, process, and resources.

- **Customer.** Tapiola's customers include individuals, families, companies, and farms, thus possibly differing from each other greatly. An insurance agreement usually includes a policyholder and a number of insured persons or items. The insured persons can include the policyholder but not necessarily. The insured items can include e.g. the vehicle in motor insurance or in home insurance the property kept in the apartment like furniture or hi-fi equipment. The size of the apartment influences the insurance policy price. Further, the characteristics of an insured person affect the terms available to him or her and also the risk-oriented pricing. An insurance policy can include a

[7] Homepages of Tapiola Group in Finnish: www.tapiola.fi, and English: www.tapiola.fi/wwweng/briefly/

number of insured persons and items whose characteristics may influence the insurance policy terms and price.

- **Needs.** Tapiola's customers buy an insurance in order to cover for risks that can happen to items or persons. Tapiola currently has an IT tool for eliciting customer needs in a consultative fashion in cooperation with the insurance clerk and the customer. The goal is to elicit customers' needs related to Tapiola's offering. The tool is also used to elicit some customer characteristics. The clerk uses the elicited needs to suggest insurance products for the customer that meet the needs. The needs of Tapiola's customers change over time in general and in situations like retirement or birth of the first child.

- **Outcomes.** What Tapiola's customers buy are insurance policies, i.e. contracts with possibly a very long duration. Tapiola's products have many options. An insurance policy can be bought for different risks, items, and persons. The options often have different levels, e.g. deductibles and amounts of indemnity can be customized. The insurance policies in general do not seem to exhibit deep compositional structure hierarchies. The options have some dependencies between them. Pricing is affected by the customer characteristics due to risk management orientation of the insurance business.

- **Process.** In insurance, it may the case that the only process affecting the customer after a purchase of insurance is the billing process. The claims handling is needed only if a risk has been realized and the customer files an insurance claim. The extent to which processes of an insurance company are affected by the policy varies. The customers can usually determine in the insurance policies how often they are billed. Overall, the processes do not vary much between different insurance policies. However, the customers do have to participate in the claims handling by initiating it and providing the right documents, receipts, etc. to the insurance company. This participation may affect the process efficiency from Tapiola's viewpoint as well.

- **Resources.** Resources do matter in the processes of an insurance company. However, how much they are affected by the insurance policy terms is unclear.

6.2 MAINTENANCE & REPAIR COMPANY

A maintenance service company Maintenance & Repair Company's (MaReCo from now on, real name of the company concealed for confidentiality reasons) business is to maintain and repair machinery. They sell maintenance service contracts.

In the following, MaReCo's services are considered from the viewpoints of customer, needs, outcomes, process, and resources.

- **Customer.** MaReCo has customers ranging from companies to persons like the buyer, users, and owners of the machinery, all possibly being different persons. The users of the machinery and the buyer are not necessarily part of the same organization. The users are often customers of the buyer of the maintenance contract. Nevertheless, the needs of the users and owners may affect the most suitable options of the maintenance contract. The maintained machinery characteristics and where they are installed, i.e. its environment, vary greatly, both issues possibly affecting the contract and the maintenance process. The maintained equipment's condition affects the services available. For example, for equipment having high fault frequency options that cover all repair costs are not available, as they would be too costly for the company.

- **Needs.** MaReCo's customer needs vary to some extent, affecting the maintenance contract most suitable for them. The equipment lifecycle affects the needs as well. After installation the users may need training to operate the machinery but not in the later stages.

- **Outcomes.** MaReCo's customers buy a maintenance contract. MaReCo's contracts have some variation in the options. However, the contracts do not exhibit deep compositional structure hierarchies. Dependencies between the options are few.

- **Process.** MaReCo has descriptions for their different process modules. However, the actual maintenance process varies little according to the options in the maintenance contract. Some variation results from the machinery and where it is installed. MaReCo's customers rarely need to participate in the process, exception being the initiation of a repair process after a machinery malfunction.

- **Resources.** Resources used in the process vary very seldom according to the maintenance contract options. In equipment inspections required by the official authorities, the inspector needs help. MaReCo can provide the help needed the inspector needs or the customers can acquire the help themselves. Some maintenance or repair tasks require specific qualifications.

7 REQUIREMENTS FOR THE CONCEPTUAL MODEL BASED ON LITERATURE AND CASE COMPANIES

This section discusses the literature review and the case companies with the aim of identifying requirements for the conceptual model, keeping in mind the intended usage of the model in a sales situation. As discussed in chapters 4.5, 5.5.1, and 6, issues like the customer, needs, outcomes, process and resources seem to be relevant issues in services. Each are discussed from the above-mentioned sales situation perspective. The modeling mechanisms required are discussed in their own section after these in 7.6. The discussion is based on chapters 5.5.2 and 5.6.

7.1 CUSTOMER

Conceptually, thinking only of the customer as person seems to be too limited. As discussed earlier in 5.5.1 and 6, the customer is not necessarily only one person. The buyer and the person(s) receiving the service are not necessarily the same person(s). The service delivery may be directed at multiple persons, groups, organizations, machinery, etc. and their characteristics can affect the service agreement (Wimmer et al. 2003, Winter 2001, Ma et al. 2002, see also 5.5.1 and cases in 6). Further, the environment of e.g. maintained machinery might also influence the service agreement (Dausch & Hsu 2003a, see also case 6.2). The aforementioned issues can affect the actual service process too and seem relevant for service configuration. Therefore, the persons, physical things, or the like the service process is directed at should be incorporated in the conceptual model. To distance from modeling just the customer (person) the conceptualization should have concepts guiding for broader thinking about the objects the service is directed at. Thus, it is suggested that object-of-service is used instead of a customer. An object as a word in this context should not be understood in the way commonly done in software engineering (like in object-oriented programming) but rather closer to its dictionary meaning[8].

In terms of variability, objects-of-services of both Tapiola and MaReCo exhibit parameterization, e.g. age and gender of a person, and structural composition, e.g. a family

[8] Merriam Webster Online Dictionary partial entry for *object:* “something mental or physical toward which thought, feeling, or action is directed”, www.m-w.com

composed to its members and in case of MaReCo, the object-of-service consists of the person buying the maintenance contract and the machinery itself.

7.2 NEEDS

Needs or similar issues are present in many of the modeling approaches. The needs provide an abstraction level in addition to the actual product characteristics. The design or development approaches apart, such phenomena are present in product configuration approaches of Soininen et al. (1998, see also 5.1.1) and Felfernig et al. (2001, see also 5.1.2) and Baida et al.'s service configuration model (2003a; 2003b; 2003c, see also 5.2). In these, the role of concepts like needs seem, from a sales configuration perspective, to be identifying the product components satisfying the needs and helping the customer to arrive at a suitable configuration. Identifying the needs might help alleviate difficulties stemming from the general complexity in any configurable product (whether goods or services) in the sales specification stage, a challenge in product configuration, see Table 4. Such difficulties may be highlighted due to the intangibility of services (see 4.1 and 4.2). Further, Tapiola's use of the IT tool (see 6.1) to identify customer characteristics and needs and subsequently recommend suitable insurance policies strengthens the point that needs should be modeled.

The variability modeling mechanisms in the current product configuration approaches seem to be sufficient for modeling needs. In the service-oriented approaches, needs are usually organized in compositional hierarchies.

7.3 OUTCOMES

Service outcomes or similar issues are present in practically every approach studied. The outcomes are understood as processes or their outputs in the development- and design-oriented approaches, with the aim being to describe *how* the service is delivered. In the approaches of Wimmer et al. (2003) and Winter (2001) the core modeled phenomena represent service agreement options, i.e. the *what* is to be delivered later with a process. Baida et al.'s (Baida et al. 2003a; 2003b; 2003c; Akkermans et al. 2004) service elements seem to exhibit both viewpoints. Wimmer et al. (2003), Winter (2001), and Baida et al. aim (Baida et al. 2003a; 2003b; 2003c; Akkermans et al. 2004) to capture *what* a customer gets rather than *how* he gets it. In the company cases, the contracts or agreements describe what the customers will receive from the company. As the goals of Wimmer et al.'s (2003), Winter's (2001), and Baida et al.'s (Akkermans et al. 2004) approaches closely resemble the goal of this thesis and judging from the company cases it appears arguable that the developed conceptualization should capture agreement options rather than direct outputs of processes. Hence, an outcome might be a misleading term and *solutions* might be a better term to describe what the customer receive and buy.

In terms of variability modeling, the studied service-oriented approaches have similar modeling mechanisms as the product configuration approaches. Some differences exist. In Wimmer et al. (2003) it is possible to group related attributes to roles, used e.g. in situations where some attributes are relevant but others are not. Consider the difference between the interesting attributes of a person in the role of an account holder or an underage account user. However, Wimmer et al.'s (2003) examples of role usage are too scant to determine if they have to be modeled. Baida et al. (Baida et al. 2003a; 2003b; 2003c; Akkermans et al. 2004) connect their service elements with the inputs required and the outputs produced, which seems reminiscent of process modeling. From the agreement perspective this arguably is not optimal as it might cause confusion and conceptual over-lapping with the process modeling perspective. In conclusion, the current product configuration approaches seem to provide appropriate variability modeling means for services as well.

7.4 PROCESS

Services are often defined as processes. This is evident especially in the service-oriented design approaches. Of the studied approaches, Wimmer et al.'s (2003) and Winter's (2001) are actually the only service-oriented ones that do not have any kind of process modeling means. The goals of their models closely remind the goal of this thesis. Baida et al.'s (Baida et al. 2003a; 2003b; 2003c; Akkermans et al. 2004) approach has similar goals as well and does include a process modeling perspective even if Baida et al. (Akkermans et al. 2004) argue that customers may not be interested in the process. Nevertheless, considering how pervasive the process is in the general service literature and many of the service-oriented modeling approaches, process aspects probably should be included in the conceptualization, even if Wimmer et al. (2003) and Winter (2001) have opted otherwise. At sales stage communicating the process to customer might be beneficial in two ways. First, as a mean to manage customer participation in the process and thus reduce customer-induced errors in the process, see 4.1 and 4.5. Second, as a mean to keep customer's expectations of the service realistic and therefore reducing customer dissatisfaction resulting from the service delivery possibly not matching to the customer's pre-delivery expectations, see 4.1 and 4.5. In Tapiola's case, the process description could be used to guide the customer to provide all the required receipts, documents, and etc. when filing for a compensation claim.

As the goal is to communicate to the customer in a sales situation what is going to happen in general terms, the level of detail in process modeling might not have to be as deep as in process design or service design.

In terms of variability modeling, the process models seem to capture predecessor-successor relations between parts of process (Bullinger et al. 2003; Baida et al. 2003a, 2003b, 2003c; Scheer et al. 2004; Ma et al. 2002) and the decomposition to more detailed descriptions (Bullinger et al. 2003; Scheer et al. 2004; Ma et al. 2002). Also present are means to describe alternative and parallel running processes (Scheer et al. 2004).

7.5 RESOURCES

Resources are present in several process models and are used to describe what is necessary for carrying out a part of a process. Another aspect captured is the customer participation i.e. the customer acting as a resource. The resources are usually modeled in a process context and not separately. Therefore resources should be included in the conceptualization and be modeled in a process context. From the variability modeling perspective, the resources can be alternatives related to each other.

7.6 MODELING MECHANISMS

This section discusses the requirements for modeling mechanisms. It is based on chapters 5.5.2 and 5.6.

An object-oriented approach with *generalization* supports the maintenance of modeled knowledge, see 5.1.1. Therefore generalization should be used in the conceptualization. Nearly all of the models in chapter 5 have a modeling mechanism for describing the structural hierarchy of the modeled entity. Based on this, it should be possible to model the *compositional structure* of services. *Parameterization* of the main concepts with attributes is also a popular mechanism and should be incorporated in the conceptualization. *Constraints* are also used in many of the models. They are useful in situations when other modeling mechanisms cannot capture an aspect of the modeled entity. Modeling connections and resource production and consumption are used in the studied product configuration approaches. However, the other studied models do not use them. Baida et al.'s service bundling (see Figure 16) with input and output interfaces of resources is similar to both but not the same. The cases did not reveal anything prompting the use of either connections or resource production and consumption. Therefore they are omitted from the conceptualization. The service modeling approaches add mechanisms to model processes where tasks precede and succeed each other, happen in parallel, and are alternatives. Process modeling mechanisms should include the possibility use these.

8 CONCEPTUAL MODEL

This chapter presents the developed conceptual model for modeling configurable services, its concepts and the possible dependencies between them. It is a synthesis, extension, and simplification of the studied approaches. First, an overview of the model is given 8.1. This is followed by a description of the general modeling concepts used in the model in 8.2 and a running example used to demonstrate it throughout this chapter in 8.3. The running example is also used to evaluate the feasibility of the conceptual model. Next, the model is discussed from its four viewpoints, here called worlds as identified in chapter 7. Finally, the dependencies between the worlds are discussed in 8.8. Throughout this chapter, the Unified Modeling Language (UML) (e.g. Booch et al. 1999) is used to define the model semi-formally in the figures.

8.1 OVERVIEW OF THE MODEL

The model is divided to four viewpoints called worlds as identified in chapter 7. The worlds have their own main concepts that are described in separate sections covering each world. This section gives an overview of the model and its worlds. There are dependencies between the concepts of a world and between the worlds. An overview of the model is represented in Figure 26.

The *objects-of-service world* describes the service recipient(s) and the environment of the recipient. The service delivery is directed at the recipient(s). The recipients can be e.g. persons as well as physical or information systems and would usually include the customer. The aim of the objects-of-service world is to specify *what the company needs to know* about the service recipient and its surroundings in order to be able to successfully configure the service at the sales stage and later on deliver the service accordingly. Furthermore, the information about the service recipient and its surroundings can help to identify the best possible solution, i.e. a configuration, for the specific recipient.

The *needs world* describes the reasons *why* a customer would want to buy the service. The needs world probably should use the customer's language. Together with the objects-of-service world the needs world can be helpful in identifying an appropriate solution for the customer.

The *service solutions world,* in turn, captures the terms and conditions, i.e. specifications or agreement, according to which the service is to be delivered. The service solutions world describes *what* the customer can buy and will be delivered. The service solutions world is the core of the model.

The *process world* outlines the service delivery process and the resources required to carry it out. The process world describes *how and with what* the service is put into practice. The aim is to describe the process at a sufficient and appropriate detail for communicating the process for the potential customer at sales configuration stage. It is assumed that this does not necessitate modeling scheduling, real-time availability of resources, or other means that can be required if the aim was to model the fulfillment processes of a company. Communicating the process to customers and especially their role in it could help to better manage customers' participation in the process and keep customers' expectations realistic, both possible contributors to service quality and customer satisfaction (Fitzsimmons & Fitzsimmons, 2004, p. 331; Grönroos 2000, p. 221; Johns 1999, see also 4.1 and 4.5).

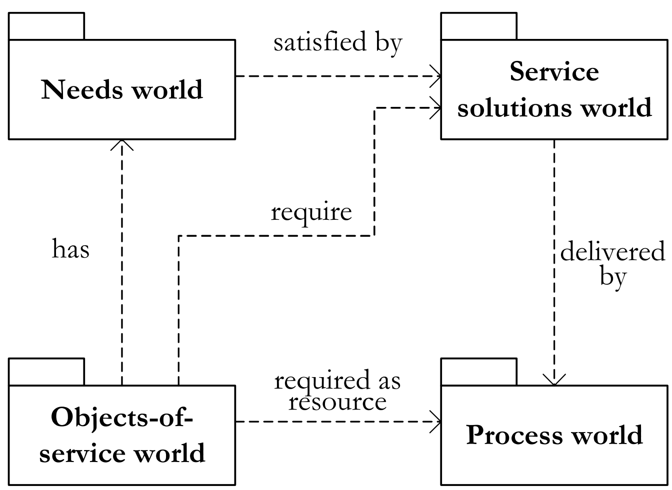

Figure 26 Overview of the model

There can be relationships between the worlds. A service recipient with certain characteristics *has* certain needs and *requires* a specific service solution. The needs are *satisfied by* particular solutions. The solutions in turn are delivered by given processes and involve certain resources. Further, a service recipient *acts as resource* for the process by either participating in it or a part of the process is directed at the service recipient. These dependencies help to identify the appropriate solutions and communicate the process required to deliver it.

8.2 GENERAL MODELING CONCEPTS

This section describes the general modeling concepts and mechanisms of the model. The metamodel of the conceptualization is shown in Figure 27. UML (e.g. Booch et al. 1999) is used in the metamodel to define stereotypes corresponding to the modeling concepts. The concepts of the model are typeset with *SMALL CAPITAL LETTERS* when first presented.

A *configuration model* defines a configurable service and its characteristics and the possibilities of customizing them with *TYPES* and their *properties* i.e. parts, attributes, and constraints. A *configuration* describes a specific instance of a configurable service as it is to be delivered. The conceptualization distinguishes between types and their instances that occur in a configuration, i.e. *INDIVIDUALS*.

Types can be arranged in *generalization* hierarchies. In a generalization hierarchy, a *subtype inherits* the properties, i.e. parts, attributes, and constraints, of its *supertypes*. Subtypes are said to be *direct subtypes* of the supertypes directly above them in the generalization hierarchy. *Direct supertypes* are defined analogously.

A type describes its compositional structure with parts. The parts are specified with *PART DEFINITIONS* defining a *PART NAME*, a *SET OF POSSIBLE TYPES* that can occur as the part, and a *CARDINALITY* describing the number of individuals that must occur as the part. Additionally, the parts of the process module types define their possible *SUCCESSORS*, explained in 8.7. The semantics of the compositional structure of process module types is that if a process module individual is carried out it means that the process module individuals as its parts are carried out as well.

A type is parameterized with *ATTRIBUTES*. The attributes characterize the type. A type defines for its attributes an *ATTRIBUTE NAME* and the *POSSIBLE VALUES* the attribute can have through its *VALUE TYPE*.

Types define *CONSTRAINTS* that specify conditions that must hold in a correct configuration. The constraints can be used to model arbitrarily complex interdependencies of the types, individuals and their properties when other mechanisms in the model are not sufficient to capture an aspect of a configurable service. The constraints are either hard or soft. A *HARD CONSTRAINT* specifies a condition that must always hold in configuration whereas a *SOFT CONSTRAINT* can be violated. The existence of a constraint language with sufficient expressive power is assumed.

There are some general modeling restrictions in the model. The types in a generalization hierarchy must be subtypes of the same direct subtype of *Type*, see Figure 27, e.g. all supertypes of a need type must be need types as well. The types in a compositional structure must be subtypes of the same direct subtype of *Type*, e.g. parts of a need type must have only need types as possible types.

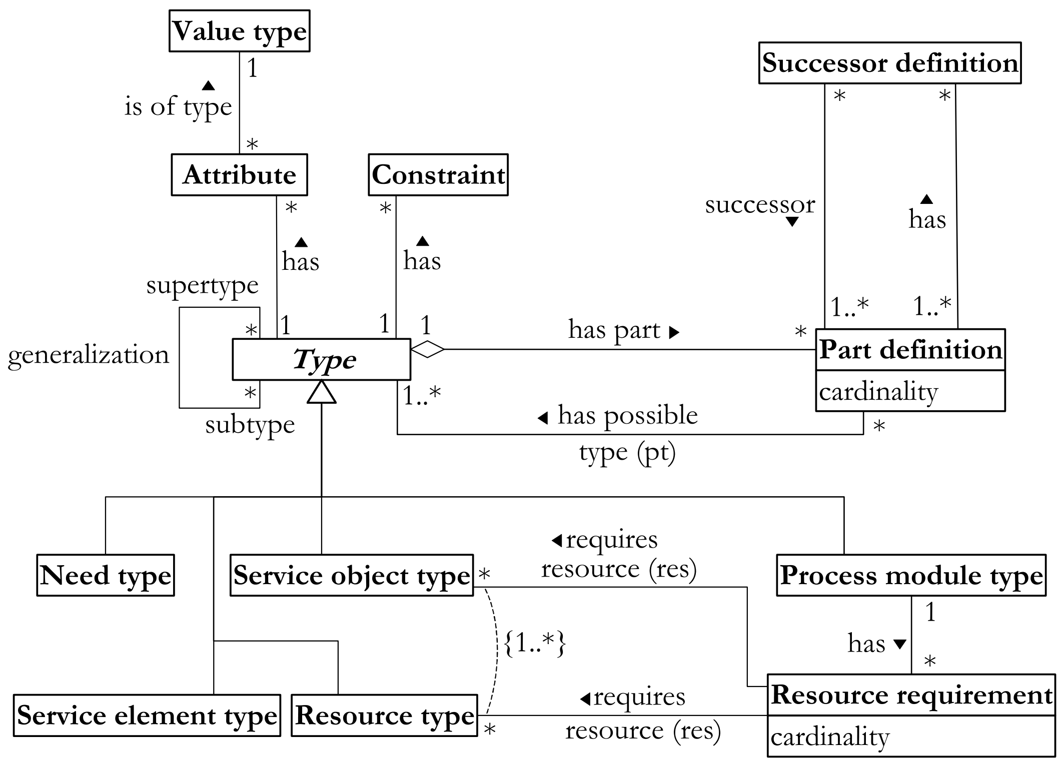

Figure 27 Metamodel

8.3 OVERVIEW OF THE RUNNING EXAMPLE

During the rest of this chapter, the conceptual model is demonstrated using an example loosely based on car insurance services of Tapiola Group, see 6.1. The configuration model based on the example is shown in Figure 28. An example configuration based on the configuration model is shown in Figure 29. The configuration model contains classes that are instances of the stereotypes defined in the metamodel, see Figure 27. The configuration in turn contains instances of classes of the configuration model. The '« »' denoting a stereotype was left out from UML association names in Figure 28 and Figure 29 for brevity.

The objects-of-service world entails the insured vehicle, a person as the policyholder and a number of insured persons that are entitled to the on-the-road support services of the insurance. The age of the car must be known as it affects the possible insurance coverage and may affect needs. The model of the car affects the authorized service station.

The needs world describes motoring-oriented needs of the customer. In case of an accident or a breakdown, it is possible to specify the desired level of accident support and whether collision damages should be covered. Further, is it possible to determine if the customer is looking for just the statutory car insurance, the best money can buy, or a compromise solution between the two.

The service solutions world consists of a car insurance solution that includes mandatory car insurance, and optionally one of two types of voluntary car insurance. The mandatory insurance fulfils the statutory requirements for car insurance. Both voluntary include coverage against theft and fire, with selectable deductibles. Collision damage coverage is optional. Budget voluntary car insurance is available only for cars that are at least six years old. It is less expensive, because cheapest accepted (third-party) parts are used for repairs and the insurance company decides where and when the car will be repaired. Extended voluntary car insurance is available only for cars that are 10 years old at the most. It has optional road assistance with two levels, normal and extended. Both levels cover towing costs, and in the extended level the insurance company also arranges towing. Extended voluntary adds the possibility for compensation for expenses to continue the trip. Further, it is possible to include the arrangement of a replacement car for the duration of repairs or redemption process.

The process world defines a process in case of a car breakdown or an accident. If towing is needed, the insurance company arranges it if the car has extended voluntary car insurance. Otherwise the customer must arrange the towing himself. After towing the car must be repaired or alternatively it has to be sent for redemption, if the car has broken beyond repair. The repair process depends on the type of the voluntary car insurance. The budget repair process is applied for cars with budget voluntary car insurance, and the normal repair process is applied to cars with extended voluntary car insurance. For the normal repair, the customer can specify if the repair should be always done in an authorized service station. In parallel with the repair or redemption, a replacement car is acquired if it has been included in the extended voluntary insurance. Either the insurance company or a person acquires the replacement car.

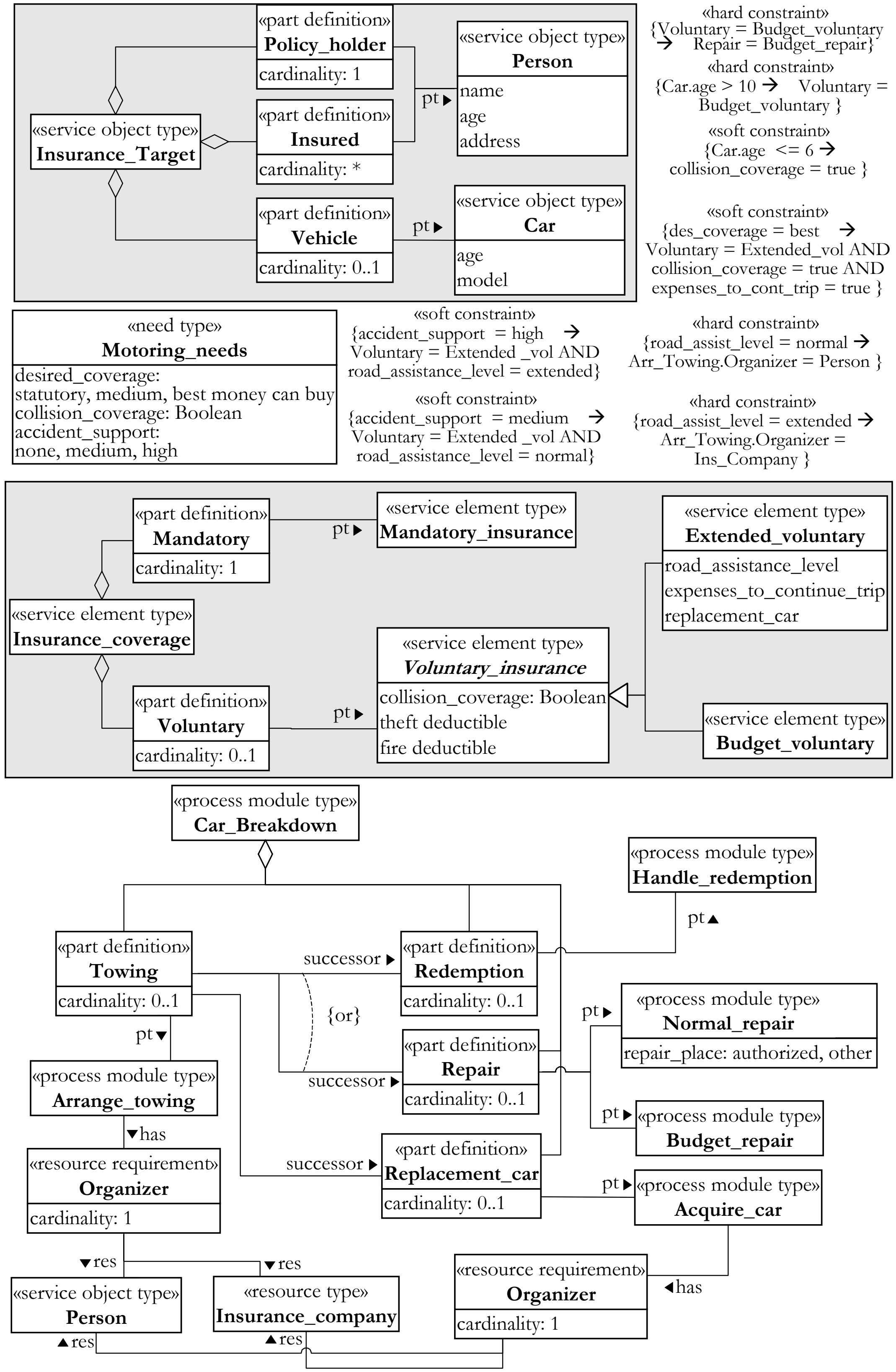

Figure 28 Example configuration model

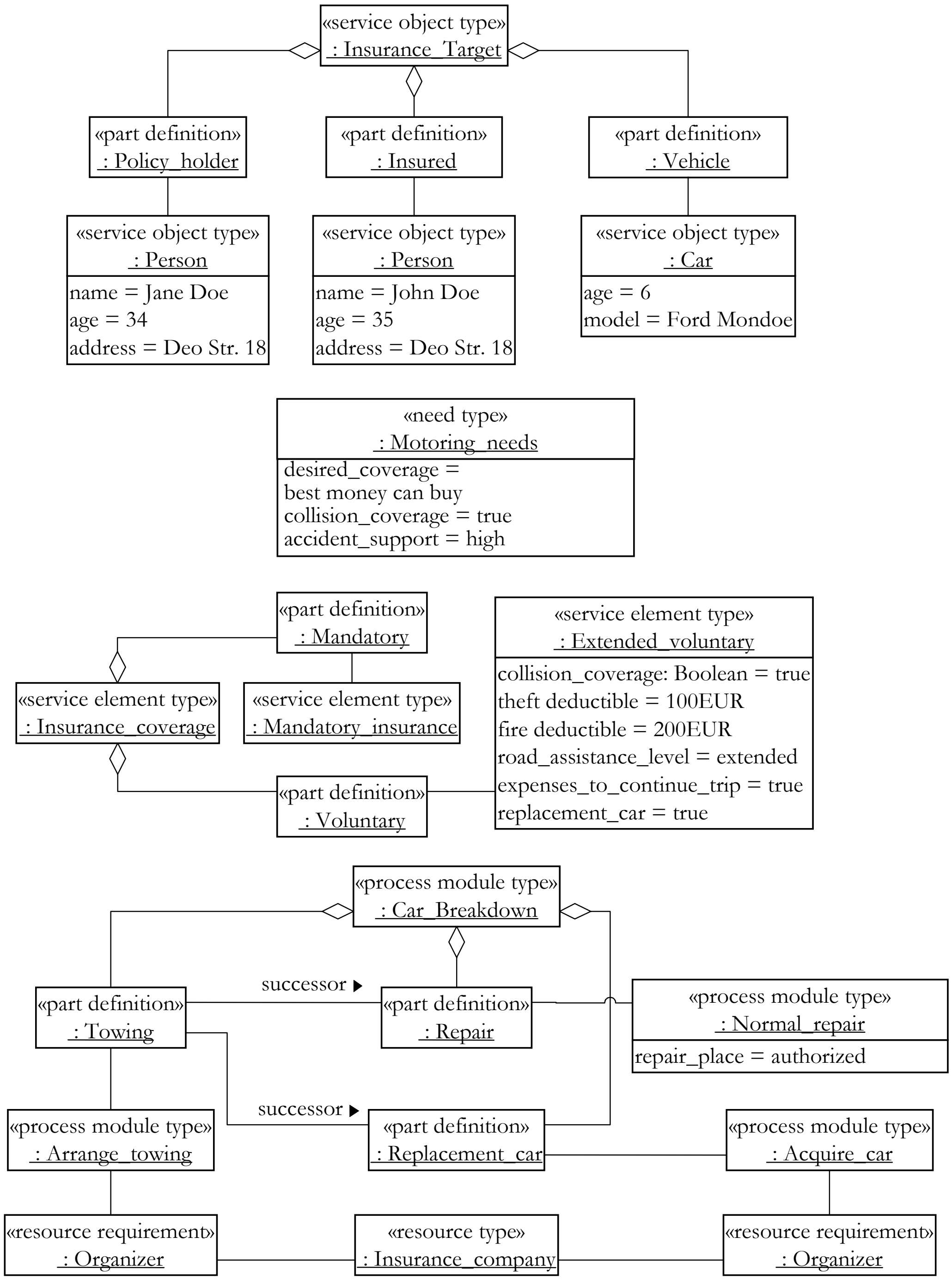

Figure 29 Example configuration

8.4 OBJECTS-OF-SERVICE WORLD

The main concept of the objects-of-service world is a *service object*. A SERVICE OBJECT TYPE is an entity representing a service recipient (like persons or physical systems) the service delivery is directed at or the environment relevant to the recipient. Examples for the service objects and their compositional structure could be a family and its members or maintained equipment and its structure.

Running example: The objects-of-service world of the configuration model includes exactly one service object type *Person* in the role of a *Policy_holder* (part definition), a number of other *Persons* as *Insured* (part definition), entitled to the on-the-road support services possibly included in the insurance solution, and a service object type *Car* as the insured *Vehicle* (part definition). Both *Person* and *Car* include characteristics the company needs to know to be able to specify and deliver the insurance solution. The configuration has one *Person* as both the *Policy_holder* and *Insured* and a 6 year old *Car* of *model* Ford Mondoe.

8.5 NEEDS WORLD

A *need* is the main concept in the needs world. A *NEED TYPE* denotes a benefit sought from a service by a customer. Basis for the compositional structure of needs can be e.g. decomposing general needs to more detailed ones, like a general need of being reachable at all times decomposed to being reachable by phone, fax, or email.

Running example: The needs world of the example configuration model consists of one need type *Motoring_needs* with attributes *desired_coverage*, *collision_coverage*, and *accident_support*. Possible values of *desired_coverage* are *statutory*, *medium,* and *best money can buy*. *Collision_coverage*'s value type is Boolean i.e. its possible values are *true* or *false*. *Accident_support* can have values *none*, *medium*, and *high*. In the example configuration, attributes have been given their "maximum" values to get the best possible insurance solution.

8.6 SERVICE SOLUTIONS WORLD

The service solutions world is centered on a *service element*. A *SERVICE ELEMENT TYPE* describes a part of the pre-delivery service specification, i.e. agreement, about what is to be delivered. Examples of the service elements and their compositional structure could be messaging services decomposed to SMS, MMS, fax, and email messaging.

Running example: The insurance consists of a service element type *Mandatory_insurance* and one of two types of service element type *Voluntary_insurance*. Both voluntary insurance types specify if collision damages should be covered and the deductibles for theft and fire. These are modeled with attributes *collision_coverage*, *theft_deductible*, and *fire_deductible*. The extended voluntary has three additional attributes: *road_assistance_level*, *expenses_to_continue_trip*, and *replacement_car* to describe the level of assistance in case of on-the-road trouble and whether the insurance covers the expenses to continue trip and if a replacement car is covered for the duration of either repairs or until the customer buys a new one in case of a redemption. The example configuration has *Extended_voluntary* with the maximum coverage possible and deductibles of 100EUR and 200EUR for theft and fire damages respectively.

8.7 PROCESS WORLD

The central concept of the process world is a *process module*. A *PROCESS MODULE TYPE* represents a task possibly carried out as part of the service delivery process. A process module may require specific *resources* to be successfully carried out. In its *RESOURCE DEFINITION*, a process module defines a *SET OF POSSIBLE TYPES* that can appear as a resource and a *CARDINALITY* describing the number of individuals that must appear as resources. These resources may be service object types (from the objects-of-service world) or *RESOURCE TYPES*. A resource type describes a physical thing, information, person, or something else that is necessary for the execution of process module(s).

In the process world part definitions take on added semantics: the *precedence* of tasks in a process is defined with the part definitions and their *successors*. A part definition defines in its *SUCCESSOR DEFINITION* the part definitions that can follow it in the process. All successors defined in a successor definition must be part definitions of the same process module type. A successor definition can determine the conditions according to which the successor(s) should be carried out, e.g. only one successor or multiple simultaneously in a parallel fashion. This allows for process branches. The semantics of the compositional structure of process modules is that if a process module individual is carried out it means that the process module individuals as its parts are carried out as well. For example, machinery repair could decompose to parts Notify of fault, Identify fault, Obtain spare parts (either from customer managed on-site stock, if available, or maintenance engineer's own supply), and Repair fault, carried out in that order. Of these, Notify of fault could require the customer as a resource depending on whether the maintained machinery has remote fault diagnostics installed or not.

Running example: The process world describes the process in case of a car breakdown or accident. The process module type *Car_Breakdown* consists of parts *Towing*, *Redemption*, *Repair*, and *Replacement_car*. Either a person or the insurance company arranges towing. Thus, process module type *Arrange_towing* requires as *Organizer* resource requirement either a resource type *Insurance_company* or a service object type *Person*. *Towing* can be succeeded in the process with acquiring a replacement car (*Replacement_car*) and either *Repair* or *Redemption* depending on if the car can be still repaired. The process module type *Acquire_car* also requires as *Organizer* either an *Insurance_company* or a *Person*. *Repair* is one of process module types *Budget_repair* or *Normal_repair* depending on the chosen voluntary insurance type. The configuration has resource type *Insurace_company* as the *Organizer* resource requirement in both *Acquire_car* and *Arrange_towing*, and *Repair* is done with *Normal_repair* process in an *authorized* service station. The successor definitions have been modeled in Figure 28 and Figure 29 only with a named association for brevity. Moreover, the fact that *Repair* and *Redemption* are alternative successors of *Towing* has been modeled with {*or*} instead of a separate successor definition in Figure 29 for brevity.

8.8 Dependencies Between Worlds

The dependencies between the worlds are modeled with constraints. Some examples of them can be found in the configuration model of the running example, see Figure 28.

8.8.1 Objects-of-Service World – Needs World

Certain service objects, or service objects with given properties, *have* specific needs. For example, a single person has different insurance needs compared to a parent with a family to care for.

Running example: *collision_coverage* is recommended for cars of at most 6 years old. This is modeled with a soft constraint {*Car.age* < *6* → *collision_coverage* = *true*} in Figure 28.

8.8.2 Objects-of-Service World – Service Solutions World

Further, similarly as above, service objects with given properties *require* certain solutions, i.e. service elements. For example, a customer owning a boat often requires a boat insurance whereas a customer without a boat does not.

Running example: *Extended_voluntary* is only available for cars at most 10 years old. This is modeled with a hard constraint {*Car.age* > *10* → *Voluntary* = *Budget_voluntary*} in Figure 28.

8.8.3 NEEDS WORLD – SERVICE SOLUTIONS WORLD

Needs are *satisfied by* specific service elements. For example, a need of being reachable at all times is satisfied by SMS, MMS, and email access with mobile phone services.

Running example: If the *desired_coverage* is *best money can buy Extended_voluntary*, *collision_coverage, expenses_to_continue_trip* are recommended. The soft constraint is {*desired_coverage = best money can buy* → *Voluntary = Extended_voluntary AND collision_coverage = true AND expenses_to_continue_trip = true*} in Figure 28.

8.8.4 SERVICE SOLUTIONS WORLD – PROCESS WORLD

Specific service elements with given properties are *delivered by* certain process modules. For example, a mobile voice mail service is delivered by processes of a company enabling the service at their end and then by a customer taking it in use, e.g. initializing passwords.

Running example: If *road_assistance_level* is normal the *Organizer* is a *Person*. In case of extended road assistance, the *Insurance_company* acts as the *Organizer*. This is true for both organizer resources, even if only the constraints handling the towing arrangement process are shown in Figure 28 for brevity.

8.8.5 OBJECTS-OF-SERVICE WORLD – PROCESS WORLD

Service objects are *required as resources* for process modules. For example, as above, a customer is required to perform actions to take a mobile voice mail in use, like initializing passwords, or manage on-site spare parts inventory.

Running example: A service object type *Person* can act as the resource requirement *Organizer* for both acquiring a replacement car and arranging the towing.

9 EVALUATION

This chapter first discusses the experiences of modeling with the conceptualization and experiences from how the conceptualization has been received in the case companies. This is followed by an evaluation of the conceptualization according to the criteria laid out in 1.2.

9.1 MODELING EXPERIENCES

Judging from the running example that is loosely and partially based on real insurance services of Tapiola, the model seems to allow modeling these services in a uniform way. In terms of modeling, the objects-of-service and the solutions worlds were the easiest. This might be because they had a clear representative in Tapiola's insurance services and marketing material. However, the process world was more difficult to model. The fact that Tapiola's material did not include process descriptions contributed to this. Another factor was that it was difficult to judge what kind of a process information would be useful for customers at the sales stage and at what level of detail should the process be captured. Most difficult was modeling the needs world, mostly due to the need being the most abstract and intangible concept in the model. It was hard to determine what needs would be easily understood by customers and would guide the selection of an appropriate solution.

The modeling was done by the ConSerWe researchers and not by Tapiola's employees. Therefore it is yet unclear how clear or intuitive the conceptualization is for service company employees when modeling. As the example is only a partial and inaccurate representative of the real insurance services, modeling a full-scale service might have identified more issues. The example was not tested with customers.

9.2 CASE EXPERIENCES

The conceptualization has not been used for configuration modeling yet in any of the ConSerWe companies. However, it has been received well. The conceptualization has been presented to employees that are responsible for services, like product managers, in three case companies. These are Tapiola and two maintenance service companies. The division to the four worlds appears to be natural for the employees. The model has been used in a workshop in one maintenance company to consider their current services and customers in a new light. Even if the experiences from the companies are still preliminary, it seems that the companies are willing to use the model at least for design-like purposes, but not yet for configuration modeling. As such, the conceptualization could prove useful for communication, documentation, and design of configurable services in the companies.

9.3 Evaluation of the Quality of the Conceptualization

This section evaluates the conceptualization according to the criteria laid out in 1.2.

9.3.1 Fit for Configurator Supported Sales Specification

The purpose of the conceptualization is to enable selling services with a configurator. The objects-of-service and needs world can be used to identify an appropriate solution for the customer. Therefore, the conceptualization arguably lends support to elicitation of customers' requirements and subsequently finding a suitable service meeting them. The conceptualization has not been tested with real customers in actual sales situations. Thus it is yet unknown how well it, if at all, supports sales specification. In the scope of this thesis, customer testing would have been difficult, as there is no tool support that incorporates the conceptualization in full.

The solutions world of one maintenance company services and part of Tapiola's have been successfully modeled with WeCoTin configurator (Tiihonen et al. 2003) that uses same variability modeling mechanisms as the solutions world does. These results cannot be shown due to confidentiality reasons. Yet, based on these experiences it is feasible to model service with the solutions world concepts.

9.3.2 Fit with the Service Domain

This fit can be evaluated from two viewpoints (Lindland et al. 1994, see also 1.2). First, a conceptualization should be appropriate for the domain (extent of statements needed in the domain) and second, for its audience (extent to which the audience is able to learn, understand, and use the conceptualization).

Conceptually, the four worlds synthesize service modeling approaches, service development, and general service literature on issues that should be captured in services. However, as the literature research probably has not been exhaustive there may be issues recognized elsewhere in literature that should be modeled for configurable services.

Nevertheless, on basis of the studied literature, the four worlds arguably present the relevant issues in modeling configurable services.

The empiric evidence of the conceptualization's fit with the service domain is limited. The running example in this thesis is only loosely based on real insurance services. The model has not been evaluated in modeling sense in other service domains yet. However, as the conceptualization has been well-received in ConSerWe's maintenance case companies, it seems arguable that the conceptualization is suitable to the maintenance service domain as well.

The employees in the case companies have not used the conceptualization for configuration modeling yet. Thus it is not known how easy it is to learn and use for modeling. However, the four worlds have been used in the companies as a way to think about their services. Listing the objects-of-service and their needs is the closest to actual modeling the conceptualization has been used in the companies. The positive feedback from these workshop- or brainstorming-like sessions indicates that the model offers a relatively natural way for the company employees to think about their services. However, in configuration modeling it is necessary to use the conceptualization in a much more detailed manner. Therefore, even if the early signs are positive, more testing is necessary.

9.3.3 Use and Domain Independent Evaluation

The conceptualization should unambiguous, i.e. each concept should have only one interpretation, concise, meaning that it should contain only the concepts that are necessary, and precise enough to serve as a basis for a software implementation (see 1.2).

The model's concepts probably are not completely unambiguous. The need concept is perhaps the most difficult to grasp as there is no clear, concrete representative for it in the real world. It is abstract and intangible. It is difficult to decide what should be modeled as needs. Baida et al. (see 5.2.2) speak of needs, wants, and demands, indicating there might be needs of different level. It is easier to find concrete representatives for service objects (like persons, machinery, etc.), service elements (service agreement options), and process modules (tasks done in service delivery). Intangibility makes it more difficult to model services in general. However, there is no overlapping between the concepts of the model. The resource concept in the conceptualization as a term has a different meaning than resource concepts in the product configuration approaches (see 5.1.1 and 5.1.2) and can thus be misleading for modelers familiar with them.

The model's concepts are concise in the sense that the same variation modeling mechanisms are used in every world and between the worlds. The worlds do represent conceptually different issues and should therefore have separate concepts. The minimal set of concepts would consist of one general concept having the same variation modeling mechanisms as the conceptualization of this thesis. Such a minimal model could arguably lose some of the fit with the service domain, see 9.3.2, the conceptualization developed in this thesis has. With separate concepts for the worlds, they are easier to differentiate when modeling. The process world contains concepts (like successor and resource type) not present in the other worlds, that are necessary for capturing the precedence of tasks and resource requirements.

The UML models in chapter 8 should define the conceptualization formally enough to serve as a basis for a software implementation.

9.4 SUMMARY

Based on the above discussion, it seems that it is feasible to model services with the conceptualization. Additionally, three of the ConSerWe case companies have expressed some willingness to use the model, if not yet for configuration modeling. However, the evaluation done is relatively limited. The conceptualization has to be evaluated further in order to establish its usefulness for modeling the knowledge important for configuring services in a configurator. The example consisted only of services in a one domain. The conceptualization has to be evaluated in other domains if any reliable judgement can be made of its generalizability outside the tested domain. However, the positive feedback from the ConSerWe maintenance company cases could indicate that the model suits to their domain as well.

10 DISCUSSION

The chapter first discusses the model on a general level before moving on to compare it to previous work. This is followed by a consideration on the limitations of the model and its evaluation. Some directions for future work close the chapter.

10.1 GENERAL

The conceptualization has not been thoroughly tested. However, on basis of the example and the initial feedback from the case companies it appears suitable for modeling configurable services. The model offers a synthesis of the previous models for configurable services. It also extends and simplifies them, based on a conceptual analysis of the service literature, existing approaches, and experiences from case companies.

The division to four worlds could be useful in modeling through separation of concerns. For some services, it may not be necessary to model all of the worlds. In such a case, the unnecessary worlds can be left out. This makes the model flexible and simplifies it in some domains while not being overly simple for others. The service solutions world forms the core of the model and is probably always present in when modeling configurable services. The objects-of-service world is likely to be present often as well and probably always includes some kind of customer in it. The needs and especially the process world might not be modeled so frequently. However, as there is not empirical evidence of this, it is difficult to state anything conclusive. Yet, the object-of-service and solution worlds seem to be easier to model than the needs and process worlds, see 9.1, which could have an effect.

During configuration, the worlds could be used to guide and phase the specification process. First, the customer characteristics would be elicited, followed with a validation of the possibly inferred needs based on the characteristics and then letting the customer to identify others. These would then be used to suggest suitable solution options for the customer, subsequently validated and supplemented by other options by the customer. This represents the customer perspective as well. The objects-of-service and needs world should use the customers' language and help to identify a suitable solution meeting the customers' requirements. Next, the process corresponding to the specified solution, and especially the customer's role in it, would be communicated to the customer based on the process world.

Looking at the worlds from another viewpoint, a conceptualization with analogous worlds could be used for configuration of goods as well. The customer characteristics and needs may influence preferred product options in goods. Similarly as above, they could be used to suggest an appropriate product for the customer. For products whose configuration decisions, delivery time, or price depend on manufacturing constraints such as availability of parts, it might be relevant to model the manufacturing process. The existing conceptualizations (Soininen et al. 1998; Felfernig et al. 2000; 2001) do have the necessary modeling mechanisms for modeling the worlds with the exception of the process world. Functions can be equated with needs. However, the conceptualizations (Soininen et al. 1998; Felfernig et al. 2000; 2001) do not have specific concepts for capturing customer characteristics, although they could be captured with components and their attributes.

10.2 Comparison with Previous Work

Modeling the customer characteristics is an important issue in financial services according to Wimmer et al. (2003) and Wimmer (2001). Ma et al. (2002) argue that customer's can be described with attributes like age, profession, or consumption tendencies and that a customer can be an individual, group of people, or an organization. In Dausch & Hsu's (2003a, 2003b) reference model, the maintained equipment plays a role in specifying service agreements. Experiences from the cases, see chapter 6, also indicate that customer characteristics should be modeled. However, none of the existing modeling approaches studied in this thesis provides specific concepts to capture the customer characteristics. The customer is present in Baida et al.'s (Akkermans et al. 2004) and Dausch & Hsu's (2003a; 2003b) models but they give no indication that the customer and his characteristics should be modeled for configuration purposes. Furthermore, issues like characteristics of the maintained equipment and the environment of the service recipient can affect the service agreements as well. In light of the above discussion it is arguable that customers or service recipients are significant for specifying service agreements and can exhibit more complexity than the mere personal characteristics of an individual. Therefore, the objects-of-service world can be considered a significant, conceptual extension to the previous work.

Similar issues as in the needs world are captured in several previous approaches. Baida et al.'s (Baida et al. 2003a; Akkermans et al. 2004) value perspective has a hierarchy of customer demands. In the product configuration approaches of Soininen et al. (1998) and

Felfernig et al. (2001), functions are used to describe the benefits or functionality a customer can get from a product, distinguishing from the concrete product parts. This is similar to the aims of the needs world. The idea of defining customer requirements or needs that are then subsequently fulfilled with processes is present in (Dausch & Hsu 2003a, 2003b; Jiao et al. 2003; Meier et al. 2002). Scheer et al.'s (2004) model includes needs and goals that are aligned to the service outputs that meet them. The conceptualization presented in this thesis offers more variability modeling mechanisms compared to the other service-oriented approaches. They do not have constraints to denote dependencies between needs. A structural hierarchy for needs is used by Dausch & Hsu (2003a; 2003b, see also 5.3.1) and Baida et al. (Baida et al. 2003a; Akkermans et al. 2004) but is not mentioned in the other service-oriented approaches. The product configuration approaches have comparable variability modeling mechanisms for functions that can be equated with needs.

Phenomena that are conceptually comparable to the solutions world have been captured in virtually every of the other approaches. The solutions world describes the service agreement, which is the core of the configurable service. In product configuration, solutions world can be equated with the basic structure and characteristics of a good. However, in Baida et al.'s (Akkermans et al. 2004, see also 5.2) model the corresponding issues are modeled in the offering perspective. The service-oriented models of Jiao et al. (2003), Daucsh & Hsu (2003a), Meier et al. (2002), Scheer et al. (2004), and Bullinger et al. (2003) seem to talk about processes at this level. In turn, the conceptualization developed in this thesis aims to make a clear distinction between the service agreement options and the processes required to deliver them and thus avoid conceptual over-lapping. Conceptual over-lapping might confuse modelers and is a sign of bad conceptual model quality (see evaluation criteria in 1.2). In the case companies, the service agreement options do not generally represent processes or their direct outcomes. The process viewpoint is perhaps natural in the mentioned models as most of them are geared towards service development and services are deemed to be processes.

Modeling processes with a precedence of tasks is mentioned in Baida et al.'s model (e.g. Akkermans et al. 2004) but not discussed further. Capturing the process is considered important in (Jiao et al. 2003; Meier et al. 2002) and the customer participation in the process by Baida et al. (Akkermans et al. 2004), Jiao et al. (2003), Scheer et al. (2004), Böhmann et al. (2003), and Ma et al. (2002). Process modeling is relatively central to the service development models. In this conceptualization, the aim of the process world is to enable communicating the process and especially the customer's role in it to the customer. This could help to reduce customer-induced variation in the process and keep customers' expectations realistic, both possible contributors to experienced service quality (Grönroos 2000, p. 221; Johns 1999; Fitzsimmons & Fitzsimmons, 2004, p. 331). However, if more detailed information about process scheduling and resource availability is necessary, more complex process modeling mechanisms may be required than are available in this conceptualization. The service development models in general exhibit more detailed process modeling mechanisms.

In terms of modeling mechanisms, a compositional structure is present in almost every one of the studied approaches. The compositional structure is used in this conceptualization in the same manner as in (Soininen et al. 1998), closely resembling also (Felfernig et al. 2001). Generalization is used in the same way as in the product configuration approaches (Soininen et al. 1998; Felfernig et al. 2001). In fact, only the process world differs from the mentioned product configuration conceptualizations in terms of modeling mechanisms. However, no need for the resource production and consumption and non-hierarchical connectivity, as used in the product configuration conceptualizations, has been identified yet from the literature and the cases. Nevertheless, due to the limited evaluation of the model in different service domains, there may be domains that exhibit the need for resource production and consumption and connectivity as modeling mechanisms, even at the sales stage.

10.3 LIMITATIONS

Some of the limitations of the conceptualization and the study have been touched upon earlier. In terms of the limitations the study, the evaluation cannot be considered to be very thorough. The conceptualization has been used to model only an example that does not consist of a full-scale service, is loosely based on real services, and represents only one domain. The evaluation of the generalizability the model is restricted to the ConSerWe's maintenance companies that have demonstrated some willingness to use the model. Further, no company employees have used the conceptualization for configuration modeling. Customer testing would be useful in order to find out whether customers see the process and needs worlds as helpful for them. The testing should be done in both consultative selling and self-service situations. However, the customer testing would require tool support, which is outside the scope this thesis. Moreover, author bias may be evident in the evaluation as the model has not been tested by others than the author.

The literature research might not have unearthed all the relevant models. Many of the models have not been published on a journal level. Even if the literature research part that used the Internet found some relevant models, it is unlikely that all have been found. Due to the vast numbers of literature on services, mass customization, and product configuration, it also unlikely that the literature research revealed all papers that could be relevant for this thesis on those subjects.

The conceptualization itself has several limitations. It may be too simple in terms of process modeling in some domains. No pricing mechanisms are in place nor any means to model changes over a customer's lifetime. The issue of what constitutes a consistent and complete configuration has not been discussed.

10.4 Future Work

Future work is required in several areas. As discussed in the previous section, the evaluation of the model is still somewhat limited. More evaluation is necessary in terms of applying the conceptualization in different domains, having company employees do configuration modeling with it, and test it in sales situations. One interesting avenue for future work could be to study how the conceptualization supports the design of configurable services. There is no modeling tool for the conceptualization and no sales configurator either. Tool support is vital if the model is to be accepted in practical use. Modeling guidelines should be written after sufficient experience from modeling configurable services with the conceptualization.

11 CONCLUSIONS

This thesis set out to find out what kind of a conceptualization would be suited to modeling configurable services from a customer perspective. Such a conceptual model is needed if service companies want to address the challenge of meeting increasingly diverse customer needs with the help of configurators, as goods manufacturing companies have done with some success. Simple adoption of the conceptualizations and tools from goods might not produce optimal results, because goods and services exhibit differences both conceptually and in practice. Literature, both on the use of existing approaches to services and conceptualizations specifically intended for services, is scarce. Therefore the conceptualization presented in this thesis addresses a problem with practical relevance and contributes, in its small part, to filling a gap in research on configuration of services.

The research was carried out using a constructive method. The relevance of the research problem was established with the above-mentioned literature gap and increased demand for customized services. After obtaining an understanding of the subject through a broad literature research spanning mass customization, configurable products, services, and relevant modeling approaches the conceptual model was developed. It was evaluated by successfully modeling an example that is loosely based on real insurance services.

The developed conceptual model consists of four worlds: objects-of-service world is intended to capture the service recipient (often the customer) characteristics, needs world for describing customer needs, service solutions world for describing the service agreements, and process world for capturing the service delivery process and customers' role in it. The model uses mostly the same variability modeling mechanisms as the existing configuration conceptualizations.

However, the evaluation of the model was limited. Only insurance services were modeled, even if the other case company represents maintenance services. However, the initial feedback from the case companies has been positive and it seems that the conceptualization allows modeling their services in a uniform way. Yet, the generalizability of the model is open to question empirically. Theoretical generalizability has more grounds. The studied approaches were from financial services, maintenance services, IT services, and services in general. The model synthesizes and extends the previous approaches, and thus could arguably be suitable to the same domains as the previous approaches.

Nevertheless, the model has to be called preliminary especially due to its limited empirical evaluation.

The model synthesizes the phenomena or concepts identified as important in previous work. It also extends previous models conceptually in terms of the objects-of-service world that captures the characteristics of the service recipient that were not captured with specific concepts in the studied existing approaches. In terms of variability modeling mechanisms, the conceptualization is very similar to the existing product configuration conceptual models. However, these do not contain modeling mechanisms or concepts to model processes.

There are several avenues for future work. Tool support is lacking. Pricing mechanisms are important if the model is to be used in practical sales. On basis of the initial company feedback the model might have potential for design of configurable services.

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