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Modeling Concepts for Choice Navigation of Mass Customized Solutions

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Abstract

Customers want individualized solutions regardless of whether the solutions comprise products, services, or any combination of them. Choice navigation support is a key capability for a company offering such mass customized solutions. We seek to identify modelling concepts for supporting choice navigation. Our findings draw from our case experiences in seven companies and scientific literature. We propose concepts such as bundles, explicit customer needs and characteristics affecting determination of the optimal solution, and high-level service co-creation process. These concepts partly extend physical product configuration conceptual models, providing a good basis for improving choice navigation support for solutions.

Key words: *Mass Customization, Services, Modelling*

1. INTRODUCTION

Customers in both B2C and B2B markets are demanding products that meet their increasingly diverse needs better. They are no longer content with standard, off-the-shelf offerings that do not fit their individual needs. More and more this also means that customers are asking for integrated problem solutions comprising both physical products and services. This is probably behind the recent increase in the research on so called product-service-systems also (see e.g. [1]). Yet, customers are not necessarily willing to wait much longer for the delivery of their solution. This has been called the customisation-responsiveness squeeze [2]. In the end customers usually tend to demand affordable prices too. Therefore, companies are squeezed between the customer demand for customised integrated solutions and the strains offering such solutions puts on the efficiency and profitability of their operations.

Mass customisation has been proposed [3] as an approach to address the challenge of meeting individual customer needs in a cost efficient manner. Mass customisation can be defined as the ability to provide products adapted to individual customer needs on a large scale at, or close to, mass production efficiency, using flexible processes [3, 4].

To implement a mass customisation strategy successfully a company needs to have three key capabilities in place [5]. First, a stable solution space consisting of modules or components that can be mixed and matched in response to individual customer requests. Second, a robust process design capable of delivering the customized solutions efficiently. Finally, choice navigation support for customers to enable them to identify the most suitable combination of modules to their needs while minimizing complexity and the burden of choosing from potentially numerous options.

One way to pursue a mass customisation strategy is through configurable products. The design of a configurable product specifies a set of pre-designed modules or components and rules on how these can be combined into valid product variants [6]. Such knowledge is called configuration knowledge. The design of a configurable product is used repetitively, in a routine manner without creative design, in the sales-delivery process to produce specifications of product variants that meet the requirements of particular customers, which is called a configuration task.

To improve the choice navigation capabilities of companies and support for the configuration task, dedicated IT system support - configurators - have been researched, developed, and applied, (see e.g. [7]). A product configurator, configurator for short, is an information system that supports the management and modelling of configuration knowledge and the configuration task [6, 7].

Past research on mass customisation has mostly focused on physical products. Mass customisation of services has received relatively little attention [4, 8, 9]. Differences between services and physical products [10, 11] imply that research results from physical products do not necessarily hold for services. A similar research gap can be noted in choice navigation support with configurators. Although several configurator systems have been developed during the past decades, these have been employed mostly for physical products (e.g. [12, 13]). The focus of attention for such systems has been on suitable product knowledge modelling concepts and formal languages based on these, and correct and efficient inference algorithms for supporting the configuration tasks (e.g. [12, 13 14, 15]). However, research on configurable or mass customisable services, and development of configurators particularly suitable for these, is relatively limited [4, 8, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25].

Yet, the economic importance of services has been growing. Moreover, the trend of increased customer demand for integrated solutions combining physical product and service components discussed earlier, has received little attention regarding how to build choice navigation capabilities and configurators suitable for such solutions. In this paper we take a step towards addressing this research gap.

Configurators provide choice navigation support by helping in defining a sales specification that can be produced, and subsequently translated into the required parts and production information (for physical products). For configurator support, any required information, or configuration knowledge in other words, has to be modelled and entered into the configurator. Usually, the modelling utilises a conceptual model describing the concepts and their relationships that are deemed necessary to capture the phenomena of interest. How well the concepts fit the domain of interest affects the quality of the conceptual model.

In this paper we present phenomena deemed relevant for capturing configuration knowledge of mass customised solutions possible comprising of physical product components or services. The identified phenomena can then subsequently be used as basis for extending conceptual models and formal modelling languages for configurators. We draw upon scientific literature and our case experiences in working with companies offering both mass customised products and services.

Rest of the paper is structured as follows. First we outline the research approach we used. Next, a short introduction to services is given as background to their characteristics and modelling phenomena related to them. A chapter on the identified modelling phenomena follows. Finally, discussion and conclusions end the paper.

2. RESEARCH OBJECTIVES AND METHODS

Our research objective was the following: what phenomena are relevant for capturing configuration knowledge related to mass customised solutions from a choice navigation support perspective?

To meet the objective we set out to review literature on configuration conceptual models, service modelling and services in general, and product-service-system models in order to identify the relevant concepts for modelling mass customised solutions. We have used both conceptual analysis of the found existing models and literature supported by our experiences in several case companies. We focused on sales support and not on more technical configuration tools that are not directly used in choice navigation support.

3. SERVICES

Unfortunately, no single and consistently used definition of what services are and are not exists [26]. This is probably why Grönroos “reluctantly” proposes in [11] the following definition for services. “A service is a process consisting of a series of 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.” Services are often characterized with the following IHIP attributes [11, 27, 28] although whether they differentiate services from goods has been questioned [29].

In services, production and consumption are simultaneous and inseparable, significant parts of the production cannot begin or proceed before some customer inputs are provided or the customer is present.

Heterogeneity refers to the variation in the worker or customer performance during the service process (assuming human involvement) and in the customer expectations of the service [28]. As customers differ their participation creates unpredictability and variation to the service process. Further, they might not necessarily know what to expect from the service process or its outcomes. Depending on the depth and complexity of the customer involvement it can be very challenging for the service company to accommodate for the customer-induced variability in the service process [10].

Intangibility is often attributed to services. It can be divided to physical intangibility, i.e. incapability to be perceived by senses or mental intangibility, i.e. difficulty in being grasped mentally [30]. Because of intangibility, customers can have difficulties in evaluating a service before purchase [11].

Perishability refers to the time-sensitivity nature of the service provider’s capacity to produce a service, not to the service product itself [28]. For example, dentist’s time is perishable if not used to the full capacity but the results of dental work are lasting for the patient.

Sampson and Froehle [28] argue that customer participation is what distinguishes service processes from other processes. In their view the customer-inputs, ranging from providing information, tangible belongings or self-inputs to the process, cause the different management challenges present in services than in goods. The customer-induced uncertainty creates management challenges that characterize especially services. In goods, customers rarely affect the production process.

Service can also be seen along two main streams: as activities, process or as outputs of a system [11]. When understood as activities a service is performed on behalf of another party, usually the customer. When seen as an output a service is “a deed”, “a performance”, “an offering”, or “a benefit”. Grönroos [11] argues that the service quality seen by customers has two dimensions: a technical (what received, outcome) and functional (how received, interactions, process) quality. In goods, the outcome consumption dominates, i.e. using the manufactured good which is produced separately from the customer.

Further, services can also be characterised as continuously rendered services, where the provider and customer may form even very long-lasting relationships (like insurance and industrial maintenance service), and as discrete transactions (e.g. hair dressers) [11]. Very relatedly to choice navigation, Grönroos [11] argues that services involve the firm giving a promise and then 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.

4. IDENTIFIED PHENOMENA

4.1 **Solutions**

A description of what the customer receives, how the customer problem is to be solved, the product options or the service outcomes, is present in all of the studied models and literature. In our case service companies, these descriptions often come in the form of service agreements or contracts.

We therefore argue that capturing the different components or options of solutions available to the customer should be possible. It is mainly amongst these options that the customer makes the decisions during choice navigation.

4.2 **Recipient characteristics**

Services are carried out for, or on behalf of, the service recipient [11]. The recipient can be e.g. a person, organisation, a technical system, or a piece of equipment as in [24] and in our industrial maintenance service cases. Wimmer et al. [20] and Winter [22] argue that modelling customer properties is important for configuration of financial services as they can affect e.g. solution option availability or pricing. Our findings in the insurance case support their views. Actually, our insurance and financial case company uses an IT tool in some sales situations to collect relevant customer characteristics and subsequently recommend suitable insurance policies and financial instruments. Further, our case experiences from industrial maintenance show that the installation environment of the maintained machinery can affect both the service process and available service options. In one broadband Internet subscription case, properties of the customer’s computer and the geographical location of customer’s apartment affect the availability of service options.

Therefore, we argue that modelling characteristics of the customer, service recipient(s), and their relevant environment would be beneficial. Such information can be useful for the service process, can affect the service agreement options, and can be used to identify and recommend a suitable solution and solution options for the customer.

4.3 **Customer needs**

The literature on service design (e.g. [11, 31, 32, 33]) usually states that the customer needs the service is supposed to satisfy should be defined. Akkermans et al. [19] include similar ideas about capturing the benefits for the customer from the service with their value perspective. The function concepts in product configuration conceptualisations of Soininen et al. [14] and Felfernig et al. [15, 34] also are used to similar things for products. Dausch & Hsu [24] model the customer goals the maintenance service is supposed to meet. One of our financial service cases uses an IT tool which elicits customer needs that are then used to recommend suitable and fitting insurance policies. The website of an Internet broadband subscription provider uses collects information about the intended use of the subscription to recommend a suitable service options.

Hence, we argue that customer needs or similar phenomena describing potential benefits of the solution would be useful in supporting choice navigation as they can be mapped to fitting solution options. It might be useful to further divide needs into goals the customer wants to achieve and risks the customer wants to avoid with the aid of the solution.

4.4 **Process and resources**

Like discussed earlier, services are often defined as processes. E.g. in the Grönroos’s [11] definition, service is a process taking place usually between the customer and the different resources of the service supplier. Further, the service design literature states that the service concept should, among other things, describe how the company intends to satisfy customers’ needs and with what kind of resources [11, 31, 32]. Processes and their necessary resources are also described in service design models of Bullinger et al. [35], Scheer et al. [33] and Ma et al. [36], in the service configuration conceptualisation of Akkermans et al. [19] and also in Dausch & Hsu’s [24] reference model for mass customisation of service agreements of heavy equipment maintenance. The customer often participates in some way in service delivery processes. This participation has to be managed to achieve good service process quality (e.g. [11]). Becker et al. [1] separate customer resources from company resources in their conceptualisation for this exact reason.

We argue that the service process stages should captured in sufficient detail that the customer can be informed during choice navigation about his or her possible role in the service process and how the process in general will take place. This could be beneficial for the smooth running of the process and for keeping the customer expectations at a desired level.

4.5 **Bundling**

Bundling of products and services is very common in many businesses [37]. Consider for example travel services where flights, guided tours, and accommodation are often sold together. In bundling, product or services that are or could be sold separately are sold bound together as a bundle. The rationale for bundling often stems from marketing. Bundles are thought to provide some sort of benefit to the customer compared to offering the contents of the bundle separately. Often buying the bundle is cheaper than buying the bundle contents separately. Bundles might be targeted at certain customer segments. Bundle contents could all address certain customer needs, be available at a certain location or at a certain time and be therefore bundled together. It is also conceivable that such bundling could be used for mass customised solutions as a mean to tackle mass confusion customers often experience when overburdened with choice. In mass customisation, customers may be faced with a huge volume of customisation possibilities during choice navigation and struggle to find the options best suitable for them. Intelligently bundling some customisation possibilities together might reduce mass confusion for customers.

In a mass customisation and product configuration conceptualisation context, bundling is conceptually different to compositional structures present in configuration conceptual models (e.g. [14, 15, 34]). Compositional structure divides the whole into its constituent parts, consider a car and its engine, chassis, gearbox, etc. for example. A bundle in a mass customised solution offering could contain both service and physical product modules or components, clearly being conceptually distinct from the compositional structure. Traditional configuration modelling is mostly concerned with accurately capturing the information required to ensure that configured solutions can actually be delivered as promised.

From configuration modelling perspective, bundling must take place within the fixed solution space of the provider. A bundle could consist of different types of solution components (both product and service) and restrict their possible parameter or attribute values. Bundles could either allow further customisation within the bundle during choice navigation or not. Such a bundle would have all its components and attribute values fixed, leaving the customer no further choices to make beyond picking the bundle itself. Bundling concepts are present in the models of Akkermans et al. [19] and Becker et al. [1].

We argue that including concepts for capturing bundles of products and services could be useful in choice navigation support.

4.6 **Long-term relationships**

For many mass customised physical products the customer relationships are transactional and choice navigation activities between the customer and the company takes place only once. In turn, for many services the customer relationships can be very long and choice navigation may take place multiple times as customer needs or the solutions offered by the company change, take life insurance for example. In contract-based, services long-term relationships between the supplier and customer are a norm.

Long-term relationships cause a twofold challenge for choice navigation support. First, customer needs or recipient characteristics may change over time and, naturally, the most suitable solution within the company's solution space may – and should – change accordingly to maintain the optimal fit. Often the solution must be adjusted when customer needs, equipment, environment or other relevant aspects change. Second, the contents of the company solution space may change; new solution components may be added and old components removed or substituted with new ones; new product generations introduced, etc. When sales rely on automated configuration support, fast updating of configuration knowledge is important and can be even business-critical (e.g. [38]).

The first challenge is related to being informed about the current needs of existing customers or recipients and possible changes in them. In some services these changes can happen somewhat predictably. A good example would be industrial maintenance services. The condition of the maintained equipment can affect the required services. Installation and setup services differ from maintenance, operation, and end-of-life services. Becker et al. [1] have included concepts for dividing the customer relationship to lifecycle phases to support identifying relevant services accordingly.

The second challenge is related to managing the configuration knowledge about the current and past product individuals and families, and is called reconfiguration (see e.g. [39]). Management of reconfiguration may be easier for services than for physical products.

The primary target of configuration in services is not a physical product individual. Therefore errors or inaccuracies in as-maintained configuration description of the product individual, and condition of components are not as relevant. Configurations of physical products are typically not affected when a company changes its product families, and product individuals evolve independently of the product family as they are modified in after-sales. Consequently, the modified product individual consists of old and new components [40]. Contrary to physical products, old service configurations can be affected when a service company changes its product families. In other words, it is possible to update a service description and contents to correspond to the new product family without physically (and expensively) modifying an existing product individual. One need not worry whether changes have been made to maintained equipment that would make it physically impossible to use spare parts the as-maintained configuration description suggests should work. Therefore, systematic “genuine” reconfiguration by replacing older components with new versions or adding and removing other components may be possible more often. Project-based modernisation taking a lot of effort and requiring design may be more common for physical products.

Long-term relationships and modelling the changes in customer needs and characteristics offer some potential business benefits. If the company notes a change in its current customer’s needs, it can then recommend suitable solutions from their existing ones that match the changed situation. Similarly, if the company introduces a new solution component that is modelled to meet certain needs or recipient characteristics, current customers with such needs can be informed and the new solution recommended for them. In the long run, the company might notice patterns in how customer needs change over time. This knowledge could be utilised for proactively recommending solutions for the customers.

It might be beneficial for companies to have separate configuration models of their customers and their solutions, at least in serving their existing customer base. Changes in product and solution configuration knowledge (pricing, new components, etc.) are probably more frequent than in ‘customer configuration knowledge’. If this is the case, handling customer information separately might be useful. Moreover, the company experts on either knowledge might not often be same persons.

Long-term relationships might not necessitate introducing new modelling concepts. Mappings between customer needs and characteristics and their corresponding solutions are possible with the phenomena and concepts already discussed. Utilising such information captured in configuration models would be a task for tool support and operations of the company. However, Becker et al. [1] introduce concepts for capturing the lifecycle phases of the industrial equipment and to map those to corresponding services. They also utilise the phases to introduce alternative payment sequences along the lifecycle and to give an estimate of the total cost of ownership (TCO) for the duration of the customer relationship, a potentially useful capability in the often investment heavy industrial equipment business.

We conclude that modelling concepts supporting lifecycle aspects could be useful, at least in some business domains like industrial services and insurance. Reconfiguration is an important problem but at least for service components of the solution it might be easier in practise.

4.7 **Pricing**

Customers are naturally interested about price during the choice navigation and how it is affected by the different customisation choices they make or would like to make. Handling pricing is therefore essential for any choice navigation support. For many industries, being able to quote a price directly and immediately is a business necessity. This implies that a customer has to know both the price of his/her current, perhaps even incomplete, customised solution and how much certain possible choices would affect the price. Configurators should support this, both during sales and modelling of the configuration knowledge. For a customised solution it is only natural that the price is not fixed but changes depending on the contents of the customised solution. Price modelling methods should therefore be able to capture many different kinds of pricing schemes.

One simple way of determining the price of a total solution would be to define the price for each solution component and then calculate the sum of all component prices in the customer’s solution. In many cases, this would be too simple. Price of two components might not be the sum of their individual prices. Determining the price might require complex logical operations taking into account the solution contents.

Moreover, the customer or recipient characteristics may affect the service productivity significantly and should therefore be taken into account also in pricing. For example, the price of a service contract for an elevator may vary depending on the age and the usage of the elevator. A maintenance service contract for a new elevator in a residential building is most likely cheaper that one for an old high-rise elevator in a commercial building, even if the contract contents would be similar. In practice, this means that simple summing of component prices is not sufficient for the pricing of mass customised solutions in the general case. At least for service components, recipient characteristics may affect the price and it should be possible to model the effect.

Bundling is often done for pricing purposes. Components sold separately might be more expensive than when sold together as a bundle. This should be supported in modelling. Price of bundle might override the prices of its components.

Pricing might also be tied to lifecycle phases in those solutions that involve long-term relationships. If the whole expected length a relationship is modelled the total price the customer would need to pay can be calculated.

Becker et al. [1] model price as an attribute of outcomes offered to customers. Related to the phenomena discussed in this paper, this would correspond to modelling price as an attribute of solution components. Becker et al. [1] also apply if-then rules for determining and calculating the value of an attribute. In other words, price is not fixed but conditional. De Miranda et al. [41] extend the model of Akkermans et al. [19] to include pricing. De Miranda et al. [41] note that the price of a service may change depending whether it is sold as a standalone or included in a bundle. In their approach, the price of a service element is determined by a condition or formula called a pricing model. A service element may offer several pricing models from which the customer may choose. The total price of a customer-specific service is the sum of all the service elements included in it minus a discount or discounts applied to the whole service or some of its elements.

We argue that modelling pricing information must be possible. Further, pricing of mass customised solutions requires mechanisms beyond simple summative of fixed prices of solution components. Expressive formulas for determining the price must be provided. Bundle pricing should be supported as well. Tying different payment plans to lifecycle phases of the customer relationship might be also useful for certain solutions.

5. DISCUSSION

The phenomena we identified are discussed here on a high level. As such they provide only a basis for extending current, more formally defined configuration conceptual models of configurators and conceptualisations used in other IT tools supporting choice navigation. We think extending the conceptualisation and modelling languages with the identified phenomena would make them to better address mass customised solutions combining both product and service components. Even if the customisation possibilities of mass customised solutions probably can be captured with current conceptualisation, we think adopting modelling concepts based on these identified phenomena would improve the conceptual fit of the conceptualisations with the domain they are used to model. The improved fit arguably would make the actual modelling task easier for domain experts.

Defining a formal conceptual model and a modelling language based on it that adopts the identified phenomena is a subject of future work. IT support for both modelling the knowledge and actual choice navigation support is also still lacking. Tool support is essential for those solutions where sales volumes are large. For other solutions documenting knowledge utilising the identified concepts might improve choice navigation support. Mass customised solutions are often by their very nature complex. For solutions combining both service and product components the complexity is probably only higher. Often company expertise is also dispersed to separate units in charge of product or service operations. Sales support for choice navigation should provide a unifying view for customers. Documentation and modelling might help provide such a view. We also had some experiences in our service case companies where utilising some of the concepts was deemed helpful during development and ideation of new services.

The review focused mostly on configuration literature and cannot be considered exhaustive. The models did exhibit some saturation of concepts nevertheless. That said, a more exhaustive review might reveal issues we have not discussed here. Reconfiguration and pricing are both complex and important issues deserving of a more thorough discussion than what could be given here.

6. CONCLUSIONS

We have identified modelling phenomena for modelling mass customised solution possibly comprising both physical products and services. We drew upon literature and our case experiences. In our view, the identified phenomena could be used to extend current conceptualisations used in choice navigation support. The extended conceptualisations could then address the characteristics of mass customised solutions more fully and with a better conceptual match than current models. This could improve the capture of relevant knowledge about the customisation possibilities of mass customised solutions by modelling. Defining formal conceptual models based on the identified phenomena and implementing IT tool support for both modelling and sales remains as future work.

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