

Mass Customisation of Services: Benefits and Challenges of Configurable Services

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Abstract

We have reviewed the dominantly goods focused literature for the main benefits and challenges of mass customisation, configurable products, and configurators and then analysed if the issues are relevant in services. The analysis is based on the conceptual differences of goods and services and is supported by our observations of two case service suppliers. Our aim is to take a small step towards filling the literature gap on mass customisation, configurable products, and configurators in service settings.

Keywords

mass customisation, product configurator, configurable products, services, configurable services, benefits, challenges, literature review, case study

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Introduction

Today, customers demand services that meet their increasingly diverse needs (Harvey et al. 1997; Papathanassiou 2004). *Mass customisation* (MC) has been proposed (Pine 1993) as a more cost-efficient solution to this challenge than full customisation (FC). MC is the ability to provide products tailored to individual customer needs on a large scale at, or close to, mass production efficiency, using flexible processes (Pine 1993; Hart 1995; da Silveira et al. 2001). One way to implement MC is through *configurable products*, a term which is in literature usually refers to goods i.e. *configurable goods*. In this paper we use the term “goods” to distinguish them from products that have a significant service dimension, as it has been argued that products always contain a service dimension (e.g. Kotler et al. 1996), be it as limited as being made available through delivery (Paloheimo et al. 2004, p. 13). The design of a configurable product specifies a set of pre-designed elements and rules on how these can be combined (in a routine manner without any creative design) into valid product individuals that meet the requirements of particular customers (Tiihonen & Soininen 1997; Salvador & Forza, 2004). Such knowledge is called *configuration knowledge*. Defining an error-free sales specification of a customer-specific product individual can be difficult because the product elements often manifest interdependencies and incompatibilities too complex to comprehend. Manufacturing suppliers have addressed this difficulty and improved their sales delivery process with *product configurators*, or *configurators* for short (Forza & Salvador 2002a; 2002b). A *configurator* is an information system that supports the creation and management of configuration knowledge (Tiihonen & Soininen 1997) and, with artificial intelligence

capabilities, supports defining an error-free sales specification (Sabin & Weigel 1998).

Several authors argue that research on services MC is sparse and merits more (McLaughlin 1996; Harvey et al. 1997; da Silveira et al. 2001). Services differ from goods in their intangibility, heterogeneity, perishability and inseparability of production and consumption (Zeithaml et al. 1985), and service transactions do not result in change of ownership (Cowell 1988). Due to these much discussed and recently challenged differences (cf. Grönroos 2000, p. 46-47; Lovelock & Gummesson 2004; Vargo & Lusch 2004), the results of research of MC of goods may not be directly applicable to services (Harvey et al 1997; da Silveira et al. 2001). Even though configurable products and configurators have been under interest recently, research on configurable products that have a significant (e.g. operating or maintenance services) or near maximal (e.g. financial services) service dimension is limited.

Thus, it is not known whether the benefits and challenges of MC, configurable goods, and configurators apply to configurable services. Suppliers contemplating whether to offer such services would benefit from this knowledge. We define *configurable services* as products with a significant service dimension, which can be customised to individual specifications from a set of options designed to meet a pre-determined range of customer needs. With this paper we seek to take a small step towards filling the literature gap on MC of services and on configurable services.

The rest of the paper is structured as follows. First, the research goals, questions, methods, and data are discussed. Next, a short summary of services characteristics is given. The subsequent part contains our main contribution, the literature review on the benefits and challenges of MC, configurable goods, and configurators and the analysis of their relevance in service settings. Finally, discussion and conclusions end our paper.

Research goals, questions, methods and data

Our goal is to find out whether the benefits and challenges of MC, configurable goods, and configurators apply to configurable services. To reach our goal we aim to answer the following research questions: 1) what are the main benefits and challenges attributed to MC, configurable goods, and configurators in literature? 2) Bearing in mind the differences of goods and services, which ones identified in the goods setting apply to configurable services?

We carried out the research as follows. First, we made a literature review on the benefits and challenges of MC, configurable goods and configurators, to identify the main ones. Next, we conceptually analysed the identified benefits and challenges for applicability in service settings, bearing in mind the differences of goods and services. The literature review and the conceptual analysis formed the main research method for this paper and we supported it with empirical case study findings, when applicable.

We searched electronic scientific databases for such terms as *mass customisation, services, customisation, product configuration, configurator, configurable products, configurable services, benefits, challenges, opportunities, threats, limitations, problems, services vs. goods, and service characteristics*. Our search yielded approximately 300 articles, books and conference papers. We then browsed the abstracts of the articles and selected about 80 publications deemed relevant for closer examination, all of which are not listed in this paper.

Our cases comprise observations on two suppliers of services, one offering equipment maintenance services in addition to manufacturing equipment, and the other financial services. The equipment maintenance service case was selected for the goods dimension involved and because of the focus of previous research on goods. The financial service case was selected due to the significance of the industry and the near maximal service dimension in their products. We used the case observations only to supplement the conceptual analysis.

Literature review and conceptual analysis

Services

A useful definition of services for the purpose of this paper is that of Fitzsimmons & Fitzsimmons (2004): “A *service is a time-perishable, intangible experience performed for customer acting in the role of co-producer*”. The usefulness stems from the definition containing two major characteristics usually attributed to services, namely intangibility and time-perishability. Further characteristics commonly cited are heterogeneity, which stems from the intangibility and customer-involvement, inseparability of production and consumption (Zeithaml et al. 1985), which leads to time-perishability, and that service transactions do not result in change of ownership (Cowell 1988). The inherent characteristics of services suggest certain challenges for service management. Such challenges include poor documentability, irreproducibility, non-storability, subjective quality assessment, and challenging process and resource management. It can be rationalized, that service mass customisation and modularisation could be utilised to alleviate the negative implications of service characteristics (Sundbo 2002; Paloheimo et al. 2004, p. 13), i.e. to decrease perishability and inseparability, to systematise heterogeneity, to document the intangible, to increase the probability of high quality and to facilitate long-term customer relationships, where relevant and desirable.

Framework for literature review on benefits and challenges

The framework we used in the benefits and challenges part of our literature review is shown in

Table 1. We identified the benefits and challenges from the viewpoints of either the supplier or customer. Further, as a supplier can move to MC (Duray 2002; Svensson & Barfod 2002) or configurable products (Tiihonen & Soininen 1997) from either MP or full customisation, also in services (Sundbo 2002), we included the direction of the move in our framework. For each benefit or challenge, we analysed its relevance in services based on the service characteristics or our case findings.

Table 1. Framework for literature review on benefits and challenges

	Supplier		Customer	
	Benefits	Challenges	Benefits	Challenges
MC	compared to MP and/or FC			
Configurable products	compared to MP and/or FC			
Configurators	compared to MP and/or FC			

Mass customisation

Supplier benefits and challenges compared with mass production

Perhaps the most cited benefit when compared with MP is the *reduction in inventories* resulting from to-order deliveries of MC without stored finished goods (Pine 1993, p. 126; Kotha 1995; Agrawal et al. 2001; Wind & Rangaswamy 2001; Zipkin 2001; Berman 2002; Broekhuizen & Alsem 2002; Svensson & Barfod 2002; Piller et al. 2004). A closely related benefit is the *reduction of product model obsolescence and fashion risk* (Kotha 1995; Agrawal et al. 2001; Zipkin 2001; Piller et al. 2004). With MC the supplier does not have to use discounts to move aging product models out of stock, like in car or fashion industry. As services are perishable it seems these inventory related benefits are not relevant in services.

A benefit that seems relevant for services is the possibility to gather *more accurate customer information* as MC often involves a continuous dialogue with customers and the information reflects actual customer information free of possible biases in market research, like panel effects (Pine et al. 1995; Hart 1995; Åhlström & Westbrook 1999; Agrawal et al. 2001; Berman 2002; Broekhuizen & Alsem 2002; Kakati 2002; Bardakci & Whitelock 2003; Franke & Piller 2004; Piller et al. 2004). The better customer information can enable faster response to market trends. MC is also said to allow *premium pricing*, due to the better fit with customer needs (Kotha 1995; Agrawal et al. 2001; Berman 2002; Broekhuizen & Alsem 2002; MacCarthy & Brabazon 2003; Piller et al. 2004; Franke & Piller 2004). Premium pricing could be feasible in mass-customised services as well (Sundbo 2002).

In MC, the customer participates in the specification of the desired product. This *customer participation in design can increase customer satisfaction* (Huffman & Kahn 1998; Wind & Rangaswamy 2001; Bardakci & Whitelock 2003) and customer willingness to pay for the customised, self-designed product (Franke & Piller 2004). Further, the *effort spent and information accumulated in the specification can become a switching cost* for the customer (Pine et al. 1995; Bardakci & Whitelock 2003; Broekhuizen & Alsem 2002; Piller et al. 2004). Switching to competition would mean spending the effort again. In a continuous relationship the information can be used repeatedly. The supplier may also learn the customers' needs so well that it becomes difficult for competitors to entice customers away. There seems to be no reason why these benefits could not be realised in services.

Table 2. Benefits for the supplier from MC compared with MP

Benefit	Relevant in services?
Reduction in inventory	<i>No</i> ; Services are perishable and therefore not storable.
Reduction in product model obsolescence; fashion risk	<i>No</i> ; Services are perishable, therefore discounts to move aging products from stock are not an issue.
More accurate customer information	<i>Yes</i>
Customer participation in design: satisfaction, effort spent a switching cost	<i>Yes</i> ; Although mass service customers participate in specification more than MP goods customers as it is.
Potential for premium pricing	<i>Yes</i>

A challenge in MC is the difficulty of *customer needs elicitation* (Huffman & Kahn 1998; Åhlström & Westbrook 1999; Zipkin 2001; Wind & Rangaswamy 2001; Berman 2002; MacCarthy & Brabazon 2003; Piller et al. 2004). Elicitation can be complex, the information

involved increases, and it is difficult to verify specification validity, in services as well. Communicating the value from a complex service offering to a customer is problematic (Devlin 1997), and the intangibility of services may even emphasise the challenge (Mathyssens & Vandenbempt 1998). Due to the simultaneous production and consumption, errors in service specification are noticed during the production and often by the customer, as opposed to errors noticed in a factory by manufacturing when they still can be corrected before delivery, albeit with costs and delays. This front-line vs. back-office dichotomy is of high research interest in services, and emphasises the importance of requirement elicitation.

Achieving the production flexibility required for MC is difficult (Kotha 1995; Åhlström & Westbrook 1999; Kakati 2002; Berman 2002; Piller et al. 2004). This is probably true in services. However, empowered human workers are flexible and could therefore make the flexibility of service production easier to achieve. A challenge relevant in services and related to both elicitation and optimal production flexibility is *finding the right amount of customisation to offer* (Berman 2002; Svensson & Barfod 2002; MacCarthy & Brabazon 2003). The supplier has to find a balance between added customer value from customisation and the accompanying complexity of management. Too much customisation may challenge management and operations too far, whereas too little or misplaced customisation compromises the added value for customers.

MC *increases both information flows and amount of information transferred* in the supplier company (Åhlström & Westbrook 1999; Zipkin 2001; Berman 2002; Broekhuizen & Alsem 2002; Kakati 2002; MacCarthy & Brabazon 2003; Piller et al. 2004). Information about the customer preferences and operations flow has to be transferred in increased amounts compared with MP and the information often needs to cross organisational and functional borders (Kakati 2002; MacCarthy & Brabazon 2003). Information transfer might be an even bigger challenge in services. In services, information arguably has to flow more frequently between persons, which is prone to errors, than in goods manufacturing. Intangibility of services often implies tacit knowledge at the customer interface.

Our case companies, aware of the difficulties mentioned above, have nevertheless initiated several measures to overcome these problems.

Table 3. Supplier challenges from MC with MP

Challenge	Relevant in services?
Elicitation: complexity, increased information, ensuring validity, right the first time	Yes; Intangibility of services may highlight the difficulties. Simultaneity of production and consumption: errors cannot be necessarily noticed before delivery, as in goods.
Difficulties in achieving the required production process flexibility	Yes; But maybe to a lesser extent, human workers allow for flexibility.
Finding balance of increased customisation and customer value	Yes
Increase in information flows and information transferred (product & customer)	Yes; Maybe even a bigger issue in services where knowledge at customer interface is often tacit and information needs to flow between persons to a larger extent than in manufacturing.

Supplier benefits and challenges compared with full customisation

Very few reports in literature quote cases of suppliers moving from FC to MC, and examine

the benefits and challenges involved. An exception is the work of Svensson & Barfod (2002), even if their focus is on the challenges. Svensson & Barfod (2002) list *improved efficiency, more uniform quality, shorter lead-times, and lower costs* among the benefits. All are benefits that can be generally attributed to increased standardisation of production and operations, also in the case of services. But standardising the process may be more difficult because of the involvement customers whose actions may be more difficult to standardise than those of service workers. Inherent heterogeneity implies variation from one encounter to another and from one customer to another. Also, customer evaluations of similar service outputs differ.

Svensson & Barfod (2002) argue that the main challenge is the change from managing the products (which they master) to *systematically managing the information* involved in customer-specific orders, its documentation, etc. Information management can be even more relevant in services, which probably involve more tacit information. Similarly as when compared with MP, the supplier has to *find the balance of offered customisation* (Berman 2002; Svensson & Barfod 2002; MacCarthy & Brabazon 2003). The compromise in this case is between added standardisation, uniform quality, and lowered costs and compromising the optimal fit of a fully customised product. This challenge is very relevant to services as well. *Customer needs elicitation* is still a challenge (Svensson & Barfod 2002), sales specification should be error-free and perhaps even more so in services, see Table 3.

Table 4. Supplier challenges from MC compared with full customisation

Challenge	Relevant in services?
Achieving uniform product quality and repeatable production	<i>Yes</i> ; Inseparability of production and consumption, customer participation and heterogeneity may even highlight difficulty.
Systemising information management	<i>Yes</i> ; Fully customised services probably involve more tacit knowledge and information.
Balancing increased standardisation and (reduced) customer value	<i>Yes</i>
Customer needs elicitation	<i>Yes</i>

Customer benefits and challenges compared with mass production

MC customer benefits have not attracted much attention in literature. The two main benefits, both also relevant to services, are the *improved fit of product with customer needs* (Pine 1993, p. 127; Kotha 1995; Agrawal et al. 2001; Wind & Rangaswamy 2001; Berman 2002; Broekhuizen & Alsem 2002; Bardakci & Whitelock 2003; MacCarthy & Brabazon 2003) and *enjoyable participation in design and specification* of the product (Huffman & Kahn 1998; Wind & Rangaswamy 2001; Bardakci & Whitelock 2003; Franke & Piller 2004). MC'd products tend to command a *higher price* than MP products, which from a customer perspective is a challenge (Hart 1995; Zipkin 2001; Agrawal et al. 2001; Wind & Rangaswamy 2001; Svensson & Barfod 2002; Broekhuizen & Alsem 2002; Kakati 2002; Bardakci & Whitelock 2003) in services also. Suppliers must justify the added price for the customers to be willing to pay the premium.

It is often mentioned that customers first *have to spend time and effort to express* their preferences (Berman 2002; Broekhuizen & Alsem 2002; Kakati 2002; Bardakci & Whitelock 2003) and then *must wait for the finished good*, as opposed to picking a product "off-the-self" (Agrawal et al. 2001; Zipkin 2001; Svensson & Barfod 2002; Bardakci & Whitelock 2003;

MacCarthy & Brabazon 2003). However, service customers, being more involved in the production process, may be more accustomed to state their preferences, and wait for the delivery of the specified service. The argued added customer value from MC should compensate for these customer sacrifices.

The customers may also suffer from the *complexity and difficulty of making choices during specification* (Pine 1993, p. 246; Pine et al. 1993; Pine et al. 1995; Huffman & Kahn 1998; Wind & Rangaswamy 2001; Zipkin 2001; Svensson & Barfod 2002; Berman 2002; Broekhuizen & Alsem 2002; Piller et al. 2004), which may be attenuated by the inherent intangibility of services. In the maintenance service case, the customers complained about having trouble to understand what the service contract options mean in practice, whereas in the financial services case, the customer service representatives suspected the customers of such trouble.

Table 5. Customer challenges from MC compared with MP

Challenge	Relevant in services?
Increased price of products	<i>Yes</i>
Time and effort spent in design, specification	<i>No</i> ; Due to perishability, service customers may be more accustomed to spend effort in specification
Waiting for the finished product	<i>No</i> ; Services are perishable and produced after purchase as it is
Complexity of design, specification	<i>Yes</i> ; Intangibility may even highlight complexity. In the maintenance service case, the customers had trouble understanding the service contract options. In the financial services case, the customer service staff suspected the customers of such trouble

Customer benefits and challenges compared with full customisation

There is some evidence in service literature that service customers appreciate the *possibility to specify their desired service from pre-determined, standard options* (Meyer & DeTore 1999; Vaattovaara 1999), which is not necessary possible in fully customised services. Choosing from standard options seems to *help in decision-making and increase trust in the provider's capability to deliver exactly as specified* (Vaattovaara 1999), and appears also to *reduce uncertainty and quicken the buying decision* (Meyer & DeTore 1999). Reproducibility and documentability may be achieved more consistently through mass customisation.

Customer challenges compared with full customisation have not been reported in literature. Possible challenges, which could apply to services as well, could be that customers have to *compromise on specification* of the product and that arriving at a suitable *specification still is a complex and difficult task*, although maybe less so than in FC.

Configurable goods and configurators

Supplier benefits and challenges from configurable goods

MP suppliers have sought to provide an *efficient way to fulfil a wider range of customer needs* (Tiihonen et al. 1996; Tiihonen & Soininen 1997; Tiihonen et al. 1998) and to *reduce inventory of work-in-progress and finished goods* (Tiihonen & Soininen 1997; Tiihonen et al. 1998). The former benefit may be realisable in services too; the latter not as services are perishable and thus cannot (or need not) be held in stock.

In turn, FC suppliers have used configurable goods when striving for *improved control of production and quality of products, shorter lead-times in sales-delivery process* (Tiihonen et al. 1996; Tiihonen & Soininen 1997; Tiihonen et al. 1998; Salvador & Forza 2004), and *reuse of knowledge* (Tiihonen et al. 1996; Tiihonen & Soininen 1997). These benefits may also alleviate the negative implications that stem from the characteristics of services. Further, the modular, pre-determined options of configurable goods have made *selling and specification easier* compared with starting from almost scratch as is often the case in FC (Tiihonen et al. 1998) and even *allowed customers to do specification themselves* (Salvador & Forza 2004). In fact, Vaattovaara (1999) discovered that selling and specification of service was easier with a clearly defined, modular service product.

A related benefit is that the pre-determined options to choose from have *reduced design effort required per customer*, which has *freed expert engineering resources to other tasks*, like new product development (Tiihonen et al. 1998; Salvador & Forza 2004). If compared with FC, customer-specific design is probably reduced with configurable services as well.

Table 6. Supplier benefits from configurable goods

Benefit	MP/ FC	Relevant in services?
Efficient way to fulfil a wider range of customer needs	MP	Yes
Smaller inventory of work-in-progress and finished goods	MP	No; Services are perishable and thus not storable
Improved control of production and quality of products	FC	Yes
Shorter lead-time in sales-delivery process	FC	Yes
Reuse of knowledge	FC	Yes
Easier selling, specification for supplier and even for customers by themselves	FC	Yes; Vaattovaara (1999) found similar results in services
Reduction in design effort per customer order, which...	FC	Yes
... freed expert engineering resources to R&D of new products		Yes

The main challenge for configurable goods when compared with MP is the *difficulty of configuring a complete and correct specification* (Sviokla 1990; Heatley et al. 1995; Fohn et al. 1995; Tiihonen et al. 1996; Tiihonen & Soininen 1997; Tiihonen et al. 1998; Sabin & Weigel 1998; Yu & Skovgaard 1998; Aldanondo et al. 1999; Aldanondo et al. 2000; Forza & Salvador 2002a; Forza & Salvador 2002b; Salvador & Forza 2004). Service intangibility may emphasise the conceptual difficulty. These kinds of errors may cause *sub-optimal fit to customer needs and iterations in the sales-delivery process* if not caught in time. The intangibility may make the errors harder to catch before delivery to customer when compared with detecting physical incompatibilities.

Several other challenges stem from the complexity of sales specification. First, *two sales configurers may come up with two different specifications for an identical order* (Sviokla 1990), relevant for services as well. Second, *sales configurers may develop repertoires of typical sales specifications that are consistent but not necessary optimal in terms of fit with needs of a given customer* (Sviokla 1990; Heatley et al. 1995; Salvador & Forza 2004). Then

the full customisation potential of the configurable good or service is not offered to the customer. Third, as sales staff often does not have the required product expertise, (technical) *product experts are much involved in checking the feasibility of specifications* in sales transactions, resulting in inappropriate use of resources (Tiihonen et al. 1998; Forza & Salvador 2002a; Forza & Salvador 2002b; Salvador & Forza 2004). This applies in services if the service experts are involved in sales transactions.

One main challenge in configurable goods is the *long term management of configuration knowledge* (Tiihonen et al. 1996; Tiihonen & Soininen 1997; Tiihonen et al. 1998; Yu & Skovgaard 1998), keeping it up-to-date and available for use. Main cause for challenge is that changes in configuration knowledge are frequent (Tiihonen et al. 1997). A related issue is the *transfer of updated configuration knowledge to sales force* (Tiihonen et al. 1996). Management of configuration knowledge is probably a problem in services as well. *Long term management of knowledge of delivered product individuals* i.e. *reconfiguration* is a related challenge (Tiihonen et al. 1996; Tiihonen & Soininen 1997; Tiihonen et al. 1998; Yu & Skovgaard 1998; Sabin & Weigel 1998). Reconfiguration is important for repair and maintenance of equipment, implementing upgrades or customer requested changes, and the like. Reconfiguration may not be as big a challenge in services as intangibles are easier to change than tangibles, although some services can have longer life-cycles than goods.

Table 7. Supplier challenges from configurable goods

Challenge	MP/ FC	Relevant in services?
Configuring a complete and correct specification difficult:	MP	<i>Yes</i> ; Intangibility may highlight difficulty.
Can specified product individual be produced/ manufactured & will it work properly?		<i>Yes</i> ; But intangibles do not suffer from incompatibilities of physical parts.
Errors noticed after sales specification phase lead to iterations in sales-delivery process		<i>Yes</i> ; However, errors may not be as easy to notice (vs. physical incompatibilities)
Does the specified product individual fit customer needs optimally?		<i>Yes</i>
Wrong, smaller price than effective cost for the specified product individual.		<i>Yes</i> ; Costing may be more difficult in services than in goods
Specifications different from (sales) configurer to configurer for identical order	MP	<i>Yes</i>
Sales staff create repertoires of typical specifications, consistent but not optimal in fit: full customisation potential not offered to customer	MP	<i>Yes</i>
(Technical) product experts heavily involved in ensuring sales specification feasibility, sales transactions	MP	<i>Maybe</i> ; Are service product experts involved in transactions?
Long term management of configuration knowledge	Both	<i>Yes</i>
Transferring (updated) configuration knowledge to sales force	Both	<i>Yes</i>
Reconfiguration: long term management of knowledge of delivered product individuals.	Both	<i>Yes</i> ; Some services may have even longer life-cycles than goods. However, changing “installed base” of intangible services may be easier than of goods

Supplier benefits and challenges from configurators

The main benefit from configurators is their ability to *reduce or even eliminate the sales specification errors and reduce effort needed* as configurators take care of the complex feasibility checks (Barker & O'Connor 1989; Sviokla 1990; Heatley et al. 1995; Fohn et al. 1995; Tiihonen & Soininen 1997; Yu & Skovgaard 1998; Aldanondo et al. 1999; Aldanondo et al. 2000; Forza & Salvador 2002a; Forza & Salvador 2002b). This can result in shorter lead-times, reduced or eliminated iterations in the sales-delivery process, and increase the volume of quotations without increasing sales staff. Configurators can help to reduce errors and effort in sales specification in services as well. However, due to simultaneity of production and consumption iterations in the sales-delivery process may not be as common in services as in goods. Configurators can also help to give a *correct or good estimate for both price* (Barker & O'Connor 1989; Heatley et al. 1995; Forza & Salvador 2002a) *and delivery-time* (Forza & Salvador 2002a), which is helpful in services as well. However, costing may be difficult in services and it is not clear if delivery-time plays as big a role in services than in goods where delivery often is a one-off occasion whereas is in services delivery, or in other words service relationship, can last a long time.

The ability of configurators to check the feasibility of a sales specification is behind many other benefits listed next. First, *sales can sell more complex goods that often are more expensive as well and engineers can design more complex goods without having to worry about specification difficulties* (Heatley 1995 et al.) These do apply in services, although it is not as a straightforward conclusion that more complex services are more expensive as well. Second, *configurators allow less skilled employees* (Bramham & MacCarthy 2004; Salvador & Forza 2004), *retailers* (Yu & Skovgaard 1998), *or even customers* (Forza & Salvador 2002b) *to do the sales specification*, probably in services as well. Third, *as configurators check the sales specifications there is no need for technical product experts in that task*, which has freed them for other tasks like new product development (Yu & Skovgaard 1998; Forza & Salvador 2002a; Forza & Salvador 2002b). Similarly as noted earlier, this benefit can apply in services if the product experts are involved in sales transactions. And fourth, configurators help *standardise specification results from sales person to sales person* (Sviokla 1990; Tiihonen et al. 1996; Forza & Salvador 2002b), which is likely in services as well.

Important benefit from configurators is their *support to create, maintain, and manage configuration knowledge* (Sviokla 1990; Yu & Skovgaard 1998; Tiihonen & Soininen 1997; Forza & Salvador 2002a). However, it is open to question if changes in configuration knowledge are as frequent in services as in goods. In terms of changing customer needs the rate is perhaps similar but whether services have the same rate of product introductions and improvements is not clear. Nevertheless, configurators also *support communicating the changes in configuration knowledge inside the supplier company, especially to sales* (Barker & O'Connor 1989; Sviokla 1990; Tiihonen et al. 1996; Tiihonen & Soininen 1997; Yu & Skovgaard 1998; Forza & Salvador 2002b). This is probably relevant in services too.

Table 8. Supplier benefits from configurators

Benefit	Relevant in services?
Reduce/eliminate specification errors (complete and correct) and reduce effort needed in specification → shorter lead-times and reduce/eliminate iterations in the sales-delivery process and increase volume of quotations without increasing sales staff	Yes; But iterations due to errors noticed after sales specification may not be as common in services anyway, because of simultaneity of production and consumption
Sales can sell more complex and expensive products and R&D can develop more complex products without having to worry about specification problems	Yes; But are more complex services more expensive?
Standardised specification results	Yes
Allows less skilled employees, retailers to do sales specification, or even by customers themselves	Yes
Reduce/eliminate need for technical experts in checking consistency, freed them for e.g. product development	Yes; But are product experts involved in sales specification in services
Correct pricing, or good estimate	Yes; Costing more difficult in services?
Correct delivery date, or good estimate	Yes; But is delivery date as important in services?
Support to maintain and manage configuration knowledge	Yes; But are changes in configuration knowledge as frequent in services?
Support for communicating/training up-to-date configuration knowledge to supplier, especially sales	Yes

The main challenge with configurators is *rapidly updating and maintaining the configuration knowledge in the configurator* (Barker & O'Connor 1989; Sviokla 1990; Fohn et al. 1995; Tiihonen et al 1996; Tiihonen et al 1998; Forza & Salvador 2002b). In cases reported by some of the earlier papers (e.g. Barker & O'Connor 1989; Sviokla 1990) updating required programming efforts, which is slow. As configurators can become the main sales support mechanism slow updates may even delay product introductions and improvements. Rapid configuration knowledge updates is a challenge in services, although rate of changes might not be as frequent in services. Related challenge is that *acquisition of configuration knowledge is a often a bottleneck, as the knowledge can be dispersed in the supplier* to different persons and functions (Barker & O'Connor 1989; Sviokla 1990; Tiihonen & Soininen 1997; Aldanondo et al. 2000; Forza & Salvador 2002a; Forza & Salvador 2002b). This can be true in services. In the financial service case, the configuration knowledge bridges organisational and product line boundaries.

Maintaining the configuration knowledge often may need people that are experts both with the configurator (have programming, modelling skills) *and the product configuration knowledge* (Barker & O'Connor 1989; Sviokla 1990; Tiihonen & Soininen 1997; Aldanondo et al. 2000) *but it should not need* (Fohn et al. 1995; Tiihonen & Soininen 1997). This is probably the case in services too, certainly so if programming is required. However, current crop of configurators often employ some modelling methods to capture the configuration knowledge. Yet, the modelling methods may be more akin to ones used in e.g. product development of goods than ones in services. This might mean that configurator experts are more important in services. A related challenge is that *the people that have both configurator and configuration knowledge expertise become critical for the supplier and them leaving a risk* (Barker & O'Connor 1989; Sviokla 1990; Tiihonen & Soininen 1997; Aldanondo et al. 2000; Forza & Salvador 2002b), in services also.

Testing configuration knowledge for correspondence to real-world is difficult (Barker & O'Connor 1989; Heatley et al. 1995; Tiihonen & Soininen 1997), in services as well. Further, *configurators do not remove the possibility for sales specification errors that arise from misunderstandings between the customer and supplier* (Tiihonen & Soininen 1997), neither in services.

Table 9. Supplier challenges from configurators

Challenge	Relevant in services?
Updating, maintaining configuration knowledge in the configurator rapidly	Yes; But are changes in configuration knowledge, product introductions as frequent in services?
Acquisition of configuration knowledge a bottleneck, often dispersed in supplier	Yes; In the financial case, configuration knowledge bridges organisational boundaries
Testing configuration knowledge	Yes
Maintaining configuration knowledge may need experts of both the knowledge and the configurator, but should not need	Yes; Knowledge in configurators is often represented in models. Modelling is not as common in services e.g. in design (?)
People with configurator and/or configuration knowledge expertise become critical for supplier, them leaving a risk	Yes
Configurators do not remove specification errors from misunderstandings with customers	Yes

Customer benefits and challenges from configurable goods

We have not found literature on the customer benefits from configurable goods. However, we believe much of the customer benefits of MC apply for configurable goods as well, like *better fit customer needs* as compared with MP and *more consistent quality* when compared with FC. As for benefits, the customer challenges have not received much attention in literature either. Yet, much of the MC customer challenges probably do apply, like *increased price*, *waiting time*, and *specification difficulty* (Forza & Salvador 2002a) when compared with MP.

Customer benefits and challenges from configurators

Due to configurators ensuring consistency of sales specifications, *customers can inspect more product alternatives and their impact and do it more freely and faster* (Forza & Salvador 2002b). This can happen with the help of sales staff with configurator support or *customers may even do the specification by themselves* (Salvador & Forza 2004). Configurator can also *help explain customers why some product alternatives are incompatible* (Aldanondo et al. 1999) and *give the price and delivery time immediately* (Salvador & Forza 2004), which are naturally of interest for the customer. All these should benefit service customers as well, although delivery time may not be as important in services as in goods because delivery of a good is usually a one-off event in time.

Table 10. Customer benefits from configurators

Benefit	Relevant in services?
Customer can inspect more alternatives and their impact and do it more freely and faster	Yes
Customers can do the specification themselves	Yes
Price and delivery time immediately	Yes; But is delivery time as important in services?
Configurator can help to explain customer why some alternative choices are not compatible	Yes

Literature mentions only a few challenges for customers from configurators. There may be *differences in the language used by customers and one used by the supplier in the configurator* (Tiihonen et al. 1998) that are possible causes for misunderstandings and frustrations for the customer. *Configurators could be easier for customers to use* (Franke & Piller 2003). Both are relevant challenges in services.

Discussion

MC literature has been reviewed from a general perspective (da Silveira et al. 2001), with the aim of recognising the MC success factors (Broekhuizen & Alsem 2002), and from the angle of customer sacrifices of MC (Bardakci & Whitelock 2003). Franke & Piller (2004) have identified empirical research in the field of MC and discuss user design toolkits for MC. Configurators are an important toolkit type. The approaches to describe, model, and formalise configuration knowledge in configurators have been reviewed earlier (Stumptner 1997; Günter & Kühn 1999). Of these previous reviews only da Silveira et al. (2001) discussed services, their aim was to motivate further research on MC of services. To our knowledge, our review is the first that tries to identify if lessons learned from MC, configurable goods and configurators could be carried over to service MC with configurable services.

We are aware that conceptual analysis can only partially answer if the benefits and challenges identified for goods apply in service settings. Further, conceptual analysis cannot spot the most important benefits or challenges in service settings. Therefore further empirical research is needed. Yet, we believe our analysis contributes to the little researched issues of MC, configurable products, and configurators in services. Most of the identified issues seem to apply in services as well, albeit to differing extents. A service supplier considering implementing MC with configurable services should probably pay heed to especially the customer needs elicitation and increased information management challenges as those arguably are even more difficult in services than in goods. The service characteristics we used as a base in our conceptual analysis have been recently challenged, especially in marketing (see e.g. Vargo & Lusch 2004; Lovelock & Gummesson 2004). As further research we could incorporate the critical views on the service characteristics into our analysis.

Conclusions

We have reviewed literature on mass customisation, configurable products, and configurators and identified the main benefits and challenges attributed to these and then analysed if the

issues are relevant in services. We based our analysis on the conceptual differences of goods and services and our experiences in two case suppliers. We believe our review highlights the literature gap dealing with mass customisation of services, configurable services, and configurator usage in services while contributing, in its small part, to filling the gap.

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