# Increasing the Attractiveness of Mass Customization: The Role of Complementary On-line Services and Range of Options

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ABSTRACT: This study investigates the antecedents of consumer intentions to use mass customization on the Internet and the joint role of complementary on-line services (visualization, salesperson interaction, and post-purchase product adaptation) and the range of mass customization options in on-line mass customization. It extends past research by demonstrating that perceptions of control and enjoyment, in addition to perceptions of product outcome and complexity, have a strong impact on consumer intentions to use an on-line mass customization process.

The study finds that both increasing the range of mass customization options and providing complementary on-line services enhance perceptions of product outcome, control, and enjoyment in using an on-line mass customization process. However, in contrast to the range of mass customization options, complementary on-line services can be increased without increasing the perceived complexity of the process. Finally, perceived control mediates the negative effect of perceived complexity on consumer intentions to use on-line mass customization.

KEY WORDS AND PHRASES: Mass customization, on-line services, perceived complexity, perceived control, perceived enjoyment, on-line interaction, on-line visualization.

In the past decade, a growing number of firms have begun to mass customize their products and services to better match consumers' needs and reduce the quantity of unsold stock [27]. Especially by using the Internet, which supports the close interconnectedness of mass customization and information technology, firms can successfully turn their mass customization strengths into a commercial advantage. For example, the apparel retailer Land's End reports that its on-line mass customization feature has had a strong positive impact on consumer loyalty [52].

Extant research on mass customization has been largely conceptual in nature and has focused mainly on production and organizational questions surrounding the implementation of mass customized manufacturing [37, 40, 55]. In operations management, researchers have studied cost-efficient ways of organizing the production and distribution process in a mass customization setting [1, 22, 68]. In e-commerce, mass customization was initially discussed within the broader perspective of customer-relationship management [58], with an emphasis on the potential of the Internet to lower the costs of collecting consumer preference data and facilitating consumer-firm interaction in product design [20, 41].

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Only relatively recently have researchers begun to address the importance of understanding the consumer's perspective on on-line mass customization and what may or may not attract consumers in different mass customization formats [63, 73]. For example, researchers have investigated the use of on-line technologies, such as "user-toolkits," to assist consumers in mass customizing their own products [24]. Also, a model of consumer choice in a mass customization setting was developed using multiple menus of different product modules [42]. In line with this research, *mass customization* is defined here as a process in which consumers can choose levels from a set of predefined product modules to compose their own most preferred alternative. For example, Dell allows consumers to choose the levels for each of the different modules of their personal computers.

This growing stream of research provides important insights into how consumers handle different on-line mass customization formats. For example, previous studies show that variations in mass customization tasks may lead to differences in perceived task complexity and customer satisfaction with the mass customization process [33]. Furthermore, the format as well as the perceived complexity of the mass customization process has been found to affect the utility of the customized product [19].

One aspect that has received little attention is how firms could offer additional on-line services that support the mass customization process without affecting the range of choice options presented to consumers [59]. If these complementary on-line services match those found in traditional retail environments (e.g., visualization of the product, interactions with sales people, flexible returns policies), they may make mass customization less complex for consumers and allow them to customize more attractive products for themselves. This would be a good solution to the practical problem found in past research where the perceived complexity of the on-line mass customization process (the only *perceived cost* associated with mass customization) was found to negatively affect the utility of the customized product [19]. Also, complementary on-line services could support on-line mass customization by strengthening the *perceived benefits* of the mass customization process, such as perceptions of product outcome, control, and enjoyment.

The purpose of the present study is to contribute to the literature on mass customization in the following ways:. First, past research is extended by investigating the joint role of complementary on-line services and the range of options in the mass customization process. Second, perceptions of control and enjoyment are included as two additional underlying benefits that determine consumer intentions to use mass customization processes, whereas past research has only looked at the trade-off between perceptions of product outcome and complexity. Third, the study investigates whether—in contrast to increasing the range of mass customization options—providing complementary on-line services enhances the perceived benefits of mass customization (i.e., product outcome, control, and enjoyment) *without* increasing the perceived cost (i.e., complexity). Last, the role of perceived control is explored to better understand the effect of perceived complexity on consumer intentions to use the on-line mass customization process.

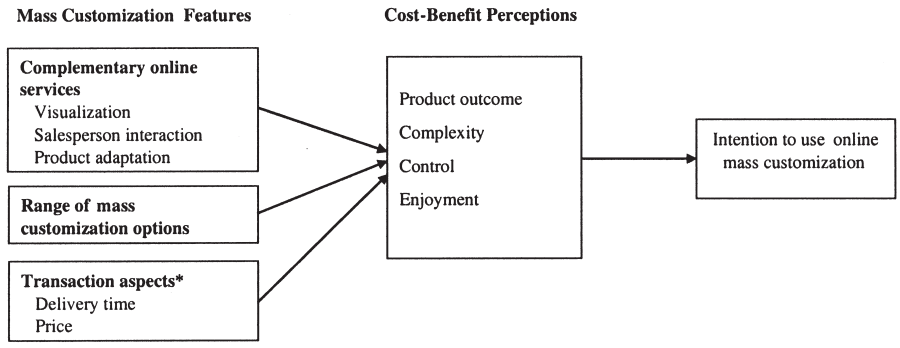


**Figure 1. Impact of Cost-Benefit Perceptions on Intention to Use On-line Mass Customization**

* Included as control variables

## Proposed Conceptual Framework

When making decisions, consumers often make mental linkages that connect product or service features to underlying perceptions of costs and benefits that drive consumer intentions to use the product or service [29]. In line with the previous literature on mass customization, e-commerce use or adoption, technology-based self-service, and the more general research on the role of benefits in consumer decision-making [13, 14, 19, 29, 51], the proposed conceptual model applies this structure to capture how on-line mass customization features influence consumers' cost-benefit perceptions, which in turn affect consumer intentions to use on-line mass customization (*see Figure 1*). Mass customization features of interest are complementary on-line services as well as the range of mass customization options.

At the level of consumer cost-benefit trade-offs, research on mass customization to date has looked at the inherent trade-off between the benefit of a better product outcome provided in mass customization and the cost of the complexity of the mass customization process [19, 33]. *Product outcome* represents the consumer's perception of the total value of the product that can be achieved by choosing product module levels according to the consumer's own specifications. *Complexity* is a cost associated with the mass customization process and refers to the consumer's perception of how complicated it is to use on-line mass customization. Based on the literature [19, 33], one would expect that positive perceptions of product outcome constitute a major factor in increasing intentions to use on-line mass customization, whereas perceptions of greater complexity of an on-line mass customization process will be a deterrent and have a negative effect on intentions to use this process.

Two more benefits—perceived control and perceived enjoyment—are added as antecedents for consumer intentions to use mass customization based on previous research on adoption of technology-based self-service [13, 14, 15]. In the context of on-line mass customization, *perceived control* is defined as the

extent to which consumers believe they are able to determine the outcome of the mass customization process, and *perceived enjoyment* as the consumer's perception of the pleasure associated with the experience of using on-line mass customization.

The desire to have control over one's environment is commonly acknowledged as a human driving force [34, 64]. Perceived control has also been shown to be a driver of e-commerce adoption, an effect that may be further enhanced by the medium, such as the Internet [51, 74]. In addition, enjoyment is known to be an important aspect of consumers' shopping experiences both on-line and offline [4, 10, 31]. Finally, research on technology-based self-service shows that perceptions of control and enjoyment positively affect consumer intentions to use this technology [13, 14, 15]. Therefore, one would expect that consumer intentions to use on-line mass customization will also increase with greater perceived control and enjoyment.

> *H1: Perceptions of (a) increased product outcome, (b) decreased complexity, (c) increased control, and (d) increased enjoyment will increase consumer intentions to use mass customization on the Internet.*

## Impact of Complementary On-line Services on Cost-Benefit Perceptions

Three complementary on-line services (visualization, salesperson interaction, and product adaptation) are studied that represent promising additional activities that on-line retailers can undertake to support consumers in the mass customization process. All three services are on-line retailer activities that are not part of the mass customization configuration process as addressed in previous research [19, 57], but are services that help the consumer compose a mass customized product. It is here proposed that these services mimic important aspects of the store shopping experience in an on-line mass customization environment to reduce the inherent uncertainty in using mass customization and to facilitate and enrich the process.

### *Visualization*

One of the main benefits of traditional physical stores is that consumers can see the actual product even before they buy it [2]. Although this possibility is strongly limited in a mass customization setting, research shows that providing customers with user-tool kits (with interactive design technology) allows them to obtain direct feedback on their new-product ideas [24, 71]. On-line visualization is an important example of this type of capability [26], representing "substitutability of personal examination" [10]. By providing immediate visual product feedback at each stage of the mass customization process (e.g., freestyle.nike.com), visualization can increase consumers' ability to interactively evaluate the products they are composing and also provide

them with a deeper understanding of the overall implications of the changes in product features [45].

### Salesperson Interaction

Consumers in traditional stores also benefit by being able to interact with sales representatives. Marketers could offer similar possibilities on-line to allow consumers to interact directly with a company representative about the product they are composing (e.g., support.dell.com). This can allow consumers to better understand product characteristics and how they relate to their particular needs [11, 41]. Social interactions with sales representatives may also assist consumers in developing and understanding their own preferences [3].

### Product Adaptation

As in store shopping, giving consumers the opportunity to have their product altered or replaced free of charge in case it fails to meet their expectations (i.e., "product adaptation") may also assist firms in overcoming consumers' inherent uncertainty about purchasing on-line mass customized products. For example, the retailer Land's End represents a well-known business case of apparel mass customization in which free returns of mass customized clothing are allowed (www.landsend.com). Product-adaptation services can reduce the purchase risk associated with on-line mass customization.

### Effect on Product Outcome

One of the most important features of complementary on-line services is that they provide consumers with greater and more useful information about the product being composed. This is valuable in any on-line shopping environment in general [44], but especially so in the mass customization context, since consumers cannot see or test the products they specify before they are actually manufactured and may not know in advance if they will be able to optimally compose a product in terms of their own desired specifications [24, 65]. Consumers may use the additional information to more accurately evaluate the effects of their specifications on a product's appearance and performance [39]. This can be done through iterative evaluations of the product composition in terms of the perceived product outcome [71].

In particular, on-line visualization has been found to partly substitute for consumers' personal examination because of the additional meaningful information it provides at every stage of the product-selection process [10, 26]. It can also create more vivid mental images of how to use a product that increase consumer intentions to use mass customization [61]. On-line salesperson interaction further allows consumers to better match products to their personal needs because it allows for more tailored and intuitive communication of

consumer product needs as well as the exchange of knowledge on how these needs can be met by the different mass customizable product features [11, 38, 57]. Finally, a product-adaptation policy allows consumers to physically inspect a product and to return or alter it if unsuitable, which in turn increases the final product outcome that the consumer receives.

> *H2a: Complementary on-line services in the form of visualization, salesperson interaction, and product adaptation will increase consumer perceptions of the product outcome of on-line mass customization.*

### *Effect on Complexity*

On-line mass customization processes may be *complex* for consumers for a number of reasons, including the number of cognitive steps required in composing a product, the difficulty of translating consumer needs in terms of product specifications, and the challenge of dealing with product uncertainty [19, 33, 54]. While the number of cognitive steps is mainly determined by the configuration of the mass customization, the latter two aspects can be partially alleviated by complementary on-line services. More specifically, the information provided by complementary on-line services—besides allowing consumers to compose more attractive products—may reduce the difficulty for them in using the on-line mass customization process.

Specifically, on-line visualization provides immediate feedback through interactive visual inspection and thus allows consumers to more easily evaluate the product they are composing and thereby overcome some of the difficulty of anticipating their needs in terms of technical product specifications [19, 45]. Salesperson interaction offers meaningful feedback and allows for direct responses that can be used to immediately clarify potential difficulties, thereby also reducing complexity. Both on-line visualization and salesperson interaction also lower the uncertainty consumers experience during the on-line mass customization process by providing them with better feedback about the product they are designing. Product adaptation also lowers the uncertainty of on-line mass customization because consumers can freely select an alternative product if they are not satisfied with the outcome of their choices [54]. Previous research suggests that lowering uncertainty will in turn reduce perceived complexity [62]. This effect is extended to the context of on-line mass customization.

> *H2b: Complementary on-line services in the form of visualization, salesperson interaction, and product adaptation will decrease consumer perceptions of the complexity of the on-line mass customization process.*

### *Effect on Control*

Although perceived control has been shown to be a driver of e-commerce adoption [51], the inherent product and process uncertainty in on-line mass customization may lower consumer perceptions of control. In particular, the

mass customization process can sometimes be challenging to consumers and they may not know how to obtain the best result [65]. As in the case of technology-based self-service [13, 15], this perceived lack of control may prevent them from using on-line mass customization. It is here proposed that offering complementary on-line services can help consumers achieve a greater sense of control in using the on-line mass customization process.

Visualization may increase perceived control because it provides consumers with clearer decision progress cues that have been shown to increase perceptions of control [72]. Jointly, visualization and salesperson support also increase process feedback in the on-line mass customization process [10, 11, 37], thereby reducing uncertainty and making consumers more capable of determining the outcome of (i.e., controlling) the on-line mass customization process [28, 74]. Finally, a product-adaptation policy offers consumers greater control by allowing them to adapt the product more closely to their taste if their initial attempt to compose a product should fail. Product adaptation may also increase perceptions of control by representing a type of product warranty [56].

*H2c: Complementary on-line services in the form of visualization, salesperson interaction, and product adaptation will increase consumer perceptions of control in using on-line mass customization.*

### *Effect on Enjoyment*

Enjoyment is important in consumers' shopping experiences across many contexts [4, 10, 31]. In mass customization, enjoyment can arise from the pleasure of participating in an attractive technology-based experience [13, 14] and from the excitement of being able to compose one's ideal product [25, 61]. Complementary on-line services may support this process and may be used to make the on-line mass customization interface more aesthetically appealing or more interactive, thereby increasing the perceived enjoyment of the on-line mass customization process [11, 45].

Enjoyment perceptions are likely to increase with visualization, because consumers tend to enjoy being able to better experience the products they are considering [30, 31]. They may become more immersed in the mass customization experience due to visual cues they themselves can manipulate, and they may enjoy attractive visualization for its own sake [46, 60]. Both aspects enrich the mass customization experience and make it more enjoyable. Similarly, consumers are likely to enjoy the social aspect of a salesperson interaction, especially if the salesperson relationship is cooperative in nature [11]. Finally, a product-adaptation policy allows the consumer to return or alter an unsatisfactory product to achieve a good product outcome, and as individuals generally enjoy performing tasks where they anticipate successful outcomes, it will increase their perceived enjoyment in using on-line mass customization [19].

*H2d: Complementary on-line services in the form of visualization, salesperson interaction, and product adaptation increase consumer perceptions of enjoyment in using on-line mass customization.*

## Effect of Increasing the Range of Mass Customization Options

On-line retailers compete, in part, on the basis of the products they offer to consumers. Normatively, the wider a retailer's assortment, the more likely that consumers can find products to their liking [32, 36]. Behaviorally, however, there is evidence that in traditional assortments consumers experience considerable difficulty in finding products that match their tastes when the assortment sizes are large [7, 35]. Although it is not well understood how consumers perform in terms of finding a suitable product in a mass customization context, it is generally expected that this would be easier than traditional assortment choice [53].

### Effect on Product Outcome

In the context of mass customization, the traditional normative role of product assortment needs to be redefined, because consumers "compose" their products by selecting levels for different modules, rather than by selecting a product from a set of predefined products. Thus, in mass customization, on-line retailers can limit or expand the total set of products available to consumers (i.e., their assortment) by varying the number of modules from which they allow consumers to choose their most preferred level. For example, an on-line apparel retailer can allow consumers to customize only the size of the clothing they buy, or can also allow for differences in style or fit. Therefore, in mass customization the number of modules available for customization can take on the traditional role of product assortment. Just as a greater product assortment allows consumers to choose products that better match their product preferences, a similar effect is expected from the range of mass customization options on perceived product outcome [19, 32].

> *H3a: A greater range of mass customization options will increase consumer perceptions of the product outcome of on-line mass customization.*

### Effect on Complexity

The benefits of greater choice in traditional assortments carry a cost in that they increase complexity for the consumer. Previous research on traditional assortments shows that behaviorally it is more difficult for consumers to find a product that matches their tastes when assortment sizes are large [7, 35]. A similar effect is expected in on-line mass customization when the range of mass customization options increases, requiring consumers to choose between a greater number of different modules [6]. Thus, providing more mass customization options will increase the required number of cognitive steps in the consumer decision-making process, thereby increasing perceived complexity.

> *H3b: A greater range of mass customization options will increase consumer perceptions of the complexity of the on-line mass customization process.*

### Effect on Control

Research shows that individuals' perceptions of control increase if they are given a choice of alternatives rather than assigned to a given alternative [34, 69]. Furthermore, allowing consumers to select from a greater number of product options has been found to be correlated to their anticipation of doing well on a decision, and should result in greater perceptions of control [9]. Similarly, one would expected that if the range of mass customization options increases, consumers can select their product from many more different options and will perceive a higher level of control.

> *H3c: A greater range of mass customization options will increase consumer perceptions of control in using on-line mass customization.*

### Effect on Enjoyment

Although increases in choice options can come at the expense of more difficult decision-making, individuals have been found to positively evaluate the experience of being able to make their own choices [8]. It has been suggested that this also applies to determining one's own product composition in mass customization [60]. This positive evaluation is likely to result in greater enjoyment, because individuals generally enjoy having the flexibility to make their own choices [17]. Therefore, a greater range of mass customization options is also expected to increase the on-line consumer's perceived level of enjoyment.

> *H3d: A greater range of mass customization options will increase consumer perceptions of enjoyment in using on-line mass customization.*

## Data and Method

### *Procedure*

The proposed model was tested using an experimental design. Respondents were presented with scenarios describing different on-line mass customization processes, and their response were captured through a questionnaire. This procedure made it possible to study consumer intentions to use on-line mass customization depending on the specific features of the process that was manipulated across scenarios. These features included complementary on-line services, range of mass customization options, and two transaction variables (delivery time and price) included as control variables. Also measured were each respondent's perceptions of product outcome, complexity, control, and enjoyment for each of the scenarios.

For realism and relevance, apparel retailing was selected as the context for the study. The clothing industry is an area in which on-line mass customization has been quite successful, and several of the larger on-line retailers offer mass

customized clothing [67]. The retail scenarios in the study described the mass customization of a pair of jeans, a clothing item familiar to most consumers. Respondents were asked to imagine that they were planning to buy a pair of jeans and were faced with the decision whether or not to use a certain retailer that offered on-line mass customization. Respondents were shown a realistic but hypothetical Web-page print that introduced a prototypical jeans mass customization Web site. They were provided with written instructions on how to complete the questionnaire as well as a brief explanation of the variables manipulated in the scenarios, as is common in conjoint analysis [21, 70]. To further familiarize respondents with the task, they first completed a practice scenario that was identical in structure to the actual scenarios but was not part of the actual study and not included in the analysis. After this, respondents provided answers to four scenarios that were used for the analyses. Four versions of the questionnaire were used, and scenarios differed between these versions (*see Appendix A* for an example of a scenario).

The respondents were 120 undergraduate students from a large university in the Netherlands. As jeans are a common fashion item among students, and as the participants in the survey were all familiar with using the Internet, they were suitable subjects for the study. The respondents received a small monetary incentive for participating. Forty-five percent of the participants were female and the average age was 22.7 (with 90% between 20 and 25).

### *Experimental Manipulations*

Each scenario used in the experiment reflected different complementary on-line services, different levels of the range of mass customization options and other "control" features that were relevant for on-line mass customization in an apparel-retailing context (*see Appendix B*). The complementary on-line services were manipulated as follows: Visualization and salesperson interaction were manipulated, respectively, by the availability of a visual representation of the mass customized product (yes, no) and the availability of direct, on-line interaction with a company representative (yes, no). Product adaptation was manipulated by the type of product-alterations policy that was available (free or for a fee). Extent of customization was represented by the number of product modules that could be customized (6 or 14 modules). These levels represented a realistic range of the number of modules that could be mass customized on real-world apparel retailing Web sites with mass customization.

As mentioned earlier, two relevant transaction aspects were incorporated in the scenarios as control variables: delivery time and price. As mass customized products are made to order, the delivery time to the consumer typically increases relative to that of standardized products (e.g., customized apparel at www.landsend.com takes 3–4 weeks to get to a customer's home, whereas standardized apparel can be delivered in less than a week). In the scenarios, manipulated delivery time was manipulated as the time between order placement and product delivery (2, 7, 14, or 21 days). These delivery times represented actual levels on real-world apparel Web sites that offer mass customization. The effect of price was captured through four different

| Features | Levels | Description |
|---|---|---|
| Complementary on-line services | | |
| Visualization | Available/Not available | Ability to have direct visual representation of customized product. |
| Salesperson interaction | Available/Not available | Ability to have direct on-line contact with company representative. |
| Product adaptation | Free alterations/Pay for alterations | Company policy regarding alterations on purchased product. |
| Range of mass customization options | Number of customization modules offered: 6 or 14 | Total number of modules available to customize product. |
| Transaction aspects | | |
| Delivery time | 2, 7, 14, or 21 days | Time between order placement and product delivery. |
| Price | €30, €50, €80, or €120 | |

**Table 1. On-line Mass Customization Features Manipulated in the Scenarios.**

levels (€30, €50, €80, €120). These prices were identical for all mass customized products within a given scenario, a pricing strategy that is common for many product variants in on-line apparel customization. As an additional control variable, the availability of standard-cut jean was manipulated on the Web site (yes, no). However, as this variable did not have any significant effects, it was excluded from the final analyses. The rest of the scenario variables and their manipulated levels are summarized in Table 1.

## *Experimental Design*

The experimental design followed an approach very similar to conjoint analysis. A fractional factorial design of 16 profiles (i.e., scenarios of Web site descriptions) was used [43]. This made it possible to estimate all the main effects in the proposed model, because all the features are manipulated independently. More specifically, the design by which the variables were manipulated in the study was a 16-profile fraction of a $2^4 \times 4^2$ full factorial by which the four on-line mass customization features (visualization, salesperson interaction, product adaptation, range of options) were varied at two levels each, and the two control features (delivery time, price) were varied at four levels. Thus, although 256 combinations were possible, only 16 combinations were necessary to accurately estimate the model [43].

The 16 profiles (or scenarios) were divided over four versions of the questionnaire, each containing four profiles (*see Appendix B*). The order of the profiles was randomized for each version, and respondents were randomly assigned to the different versions. Each respondent evaluated only one version (i.e., four profiles or scenarios) to yield a total of 480 observations.

### Measurement

For each scenario, respondents were asked to indicate whether or not they would use the on-line mass customization described in the scenario if it were available in reality. Their yes-no response to this question constituted the dependent variable in the model (i.e., consumer intention to use on-line mass customization) [19].

The respondents were also asked to report on their cost-benefit perceptions for each scenario they read. To measure perceptions, existing scales were adapted from previous research. For product outcome, two scale items by Zirger and Maidique were adapted [75]. The scale items for "complexity" (4 items), "enjoyment" (4 items), and "control" (2 items) were adapted from Dabholkar [13]. All the scales used a seven-point Likert scale (1 = strongly agree, 7 = strongly disagree). Appendix C shows the items for all constructs.

Cronbach's alphas for the scales were 0.82 for complexity, 0.81 for control, 0.91 for enjoyment, and 0.77 for product outcome. Confirmatory factor analysis (CFA) was conducted on the cost-benefit perceptions, correcting for the fact that repeated measures had been obtained from each individual. This analysis was done using the Mplus software package, which allows for a multilevel structure in the data when conducting CFA [48]. The CFA showed a good fit ($\chi^2 = 132.64$, $df = 48$, RMSR = 0.05, RMSEA = 0.06, NNFI = 0.93, and CFI = 0.95), providing evidence of convergent validity. The good fit indices lend support for the construct validity of the individual constructs in the model. Correlations among the cost-benefit perceptions ranged from 0.07 to 0.42, providing evidence of discriminant validity.

### Controlling for the Impact of Complexity on Product Outcome and Control

The model also controls for two possible effects of perceived complexity on consumer benefit perceptions suggested in previous literature. First, because perceived complexity forces individuals to use simplifying decision heuristics, it is less likely that consumers can compose products that provide them with high utility [16, 19, 49]. Therefore, complexity, which in itself lowers consumer intentions to use on-line mass customization, may also have a negative effect on product outcome. Second, in complex on-line mass customization processes, it may be more difficult for consumers to achieve high utility, making them feel less able to determine the outcome of the mass customization process, and therefore complexity may also lead to lower perceptions of control [23, 34]. The analytical model accounts for these possible effects of perceived complexity on perceived product outcome and perceived control.

### Analytical Model

Consumer intentions to use a certain on-line mass customization process are modeled using consumer choice theory as the basic framework [47]. It is as-

sumed that consumers will use a certain on-line mass customization process if they expect that doing so will provide them with a higher utility than using an alternative on-line mass customization process. $V_{ir}$ is the systematic utility of on-line mass customization process $r$ to consumer $i$, and $\varepsilon_{irt}$ is an error term specific to the consumer ($i$), process ($r$), and observation ($t$) that captures unexplained variation in consumer choices due to measurement error and unobserved explanatory variables. The utility $U_{irt}$ of an on-line mass customization process is expressed as: $U_{irt} = V_{ir} + \varepsilon_{irt}$.

The consumer intends to use a certain on-line mass customization process if the utility of using the process exceeds the utility $U_{iot}$ of all other ways ($o$) to obtain the product of interest. The probability ($P(r \mid i)$) that consumer $i$ will choose on-line mass customization process $r$ is expressed as $P(r \mid i) = P(U_{irt} > U_{iot})$.

Systematic utility is expressed as a function of the vector of the consumer's cost-benefit perceptions of the on-line mass customization process ($\mathbf{Z_{ir}}$) with a vector of individual specific parameters $\gamma_i = \gamma + \chi_i$, where $\gamma$ is the vector of the average effect across all individuals for each of the perceived benefit constructs in on-line mass customization, and $\chi_i$ is a vector of individual specific error components that capture remaining unexplained variations in taste between consumers as well as individual specific errors in the measurement of the perceived-benefit constructs. A random coefficient intercept $\alpha_i = \alpha + \nu_i$ is also included to capture the remaining unexplained heterogeneity in taste between consumers. It is assumed that all errors $\eta_i$ and $\nu_i$ are independently normally distributed. Therefore $V_{ir} = \alpha_i + \gamma_i \mathbf{Z_{ir}}$.

To express the probability that a consumer intends to use a certain on-line mass customization process, an individual specific utility $U_{iot}$ is defined for a consumer's best possible alternative way of obtaining the product of interest: $U_{iot} = \alpha_i^o + \varepsilon_{irt}^o$, where $\alpha_i^o$ is an individual specific constant and $\varepsilon_{irt}^o$ is the related error component. The binary random coefficients logit model is obtained by normalizing $\alpha_{irt}^o$ to zero, and assuming that the error terms $\varepsilon_{irt}$ and $\varepsilon_{irt}^o$ are independently and identically Gumbel-distributed. The models are estimated using the smooth simulated maximum likelihood procedure in LIMDEP [66]. This approach allows for estimates of the means of dependent variable (i.e., intention to use) along with estimates of the standard deviations of these means based on the distribution in the sample.

To model cost-benefit perceptions as a function of complementary on-line services, range of mass customization options, delivery time, and price, the following random coefficients equations structure is formulated: $\mathbf{Z_{ir}} = \alpha_i^{\mathbf{B}} + \beta \mathbf{X_{ir}} + \delta C_{ir} \eta_i + \varepsilon_{irt}^{\mathbf{B}}$, where $\mathbf{Z_{ir}}$ is the vector of a consumer's cost-benefit perceptions of the on-line mass customization process, $\alpha_i^{\mathbf{B}} = \alpha^{\mathbf{B}} + \nu_i^{\mathbf{B}}$ is a vector of random coefficient intercepts for each of the cost-benefit perceptions, $\mathbf{X_{ir}}$ is a consumer's vector of relevant features scores that are independent variables to explain cost-benefit perceptions, $\beta$ is a matrix of coefficients for the feature scores, $\delta$ is a dummy variable, with a value of one for the effect of complexity on product outcome and control, and zero for the effect of complexity on itself and enjoyment, $C_{ir}$ is the perceived complexity score, $\eta_i = \eta + \tau_i$ is a vector of random coefficients for the complexity perception effect, and $\varepsilon_{irt}^{\mathbf{B}}$ is a vector of error terms. Separate models are estimated for each cost-benefit perception, and all errors are assumed to be independently normally distributed both within and

| Cost-benefit perceptions | Model A, with all four cost-benefit perceptions | | Model B, without control | |
|---|---|---|---|---|
| | Parameter | *t*-value | Parameter | *t*-value |
| Product outcome | 0.93 | 12.97* | 0.99 | 13.69* |
| Complexity | -0.08 | -1.42 | -0.12 | -2.04* |
| Control | 0.26 | 4.43* | n.a. | |
| Enjoyment | 0.30 | 4.96* | 0.40 | 6.75* |
| Pseudo $R^2$ | 0.38 | | 0.37 | |

**Table 2. Models of Intentions to Use On-line Mass Customization: Effects of Cost-Benefit Perceptions.**

*Notes:* $N = 120$. Model estimates based on random coefficient logit model. The pseudo $R^2$ expresses the improvement in log-likelihood of the estimated model compared to a baseline model with only the intercept.
* Significant at the 95% confidence level.

between benefits. A simulated maximum likelihood technique is used similar to the one used to estimate the model for consumer intentions to use on-line mass customization to capture the repeated measures nature of the data.

## Results

Respondents reported an intention to use on-line mass customization 35.8% of the time (172 yes responses). Average scores for cost-benefit perceptions were 3.89 ($SD = 1.61$) for product outcome, 4.15 ($SD = 1.36$) for complexity, 4.34 ($SD = 1.54$) for control, and 4.40 ($SD = 1.47$) for enjoyment.

The results of the model estimates that capture the effects of cost-benefit perceptions (i.e., three benefits and one cost) on intentions to use on-line mass customization (H1) are here summarized (*see Table 2, Model A*). All three benefit-perceptions (product outcome, control, enjoyment), as expected, have significant positive effects on intentions to use on-line mass customization, thus supporting hypotheses H1a, H1c, and H1d. However, although the negative effect of perceived complexity on intention to use is in the correct direction, it is not significant. Thus, H1b is not supported.

Also as expected, complementary on-line services and the range of mass customization options are found to have significant effects on all four cost-benefit perceptions (thus supporting H2 and H3). As seen in Table 3, adding complementary on-line services to on-line mass customization increases product outcome (H2a), decreases complexity (H2b), and increases control (H2c) and enjoyment (H2d). Specifically, nine out of the 12 separate effects hypothesized in H2 were found to be significant (*see Table 3*). Furthermore, in line with previous research, a greater range of mass customization options increases product outcome but does so at the expense of increasing complexity, thus supporting both H3a and H3b [19]. The range of mass customization options also has positive effects on control (H3c) and enjoyment (H3d), as hypothesized, to extend the literature. Finally, the results of the models at the

| | Product outcome | | Complexity | | Control | | Enjoyment | |
|---|---|---|---|---|---|---|---|---|
| **Features** | **Parameter** | ***t*-value** | **Parameter** | ***t*-value** | **Parameter** | ***t*-value** | **Parameter** | ***t*-value** |
| Complementary on-line services | | | | | | | | |
| Visualization | 0.15 | 3.87* | -0.14 | -4.22* | 0.28 | 6.85* | 0.18 | 5.09* |
| Salesperson interaction | -0.00 | -0.06 | -0.09 | -2.84* | 0.11 | 2.80* | 0.12 | 3.43* |
| Product adaptation | 0.11 | 2.96* | -0.06 | -1.75 | 0.16 | 3.71* | 0.05 | 1.49 |
| Range of mass customization options | 0.10 | 2.56* | 0.15 | 4.85* | 0.38 | 8.96* | 0.13 | 3.99* |
| Transaction aspects | | | | | | | | |
| Delivery time | -0.11 | -3.06* | 0.08 | 2.65* | 0.09 | 2.47* | -0.10 | -3.07* |
| Price | -1.57 | -14.82* | 0.17 | 1.60. | -0.06 | -0.46 | -0.54 | -5.52* |
| Complexity§ | -0.13 | -4.42* | n.a. | | -0.29 | -9.72* | n.a. | |
| Pseudo $R^2$ | 0.09 | | 0.08 | | 0.06 | | 0.09 | |

**Table 3. Models of Cost-Benefit Perceptions: Effects of On-line Mass Customization Features.**

*Notes:* $N = 120$. Model estimates based on random coefficient logit model. The pseudo *R*-square expresses the improvement in log-likelihood of the estimated model compared to a baseline model with only the intercept. § Complexity was included as an explanatory variable in the Product outcome and Control models to allow for possible negative effects of Complexity on these benefits. * Significant at the 95% confidence level.

level of cost-benefit perceptions provide support for the expected negative effects of complexity on product outcome and control.

## Testing Alternative Models

A further analysis was conducted to investigate the lack of support for H1b (i.e., the finding that complexity had no direct effect on consumer intentions to use on-line mass customization). As complexity was significant in past research but not in the present study, this suggests that one of the new cost-benefit perceptions may act as a mediator of the effect of complexity on intentions. Such mediation could explain the difference between the present findings and earlier research that demonstrated a significant negative effect of complexity on intentions to use mass customization but that did not account for the effects of control and enjoyment [19]. Control seemed the most likely candidate for such a mediation effect because the study found evidence of complexity on control (*see Table 3*). It was therefore dropped in the model to test for a possible direct effect of complexity on intention to use on-line mass customization. The results of the model with product outcome, complexity, and enjoyment as the three explanatory variables for on-line mass customization do indeed confirm this tentative hypothesis (*see Table 2, Model B*) when grouped with the earlier result that complexity had a significant negative effect on control (*see Table 3, last row*). As found in this restricted model, complexity has a significant negative effect ($p < 0.05$) on intentions to use on-line mass customization, which is in line with earlier research [19]. Jointly, these results suggest a mediating role for control on the effect of complexity on consumer intentions to use on-line mass customization.

The proposed model was also prepared against two alternative models that did not include the mediating role of cost-benefit perceptions between on-line mass customization features and intention to use mass customization [5]. The first alternative model included cost-benefit perceptions and mass customization features as separate and equivalent independent variables without mediation effects. The second alternative model included only the mass customization features as independent variables and not the cost-benefit perceptions. If the effects of the mass customization features are *not* significant in the model that includes both features and cost-benefit perceptions, but *are* significant when only features are included, one may conclude that cost-benefit perceptions fully mediate the effect of features on intentions. If both types of effects are significant in the first model, one would conclude that cost-benefit perceptions partially mediate the effect of features. These conclusions also take into account the earlier analyses showing significant effects of mass customization features on cost-benefit perceptions (*see Table 3*).

Table 4 reports the results of the alternative models. The first model, with both cost-benefit perceptions and features as independent variables (*see Table 4, Model C*), showed significant effects of the three cost-benefit perceptions on intentions to use on-line mass customization, as found previously in Table 2. The effect of complexity was once again not significant. The results of this model also showed that most on-line mass customization features had no significant effect on intentions to use on-line mass customization when cost-benefit per-

| | Model C, with cost-benefit perceptions and on-line mass customization features | | Model D, with only on-line mass customization features | |
|---|---|---|---|---|
| | **Parameter** | ***t*-value** | **Parameter** | ***t*-value** |
| Cost-benefit perceptions | | | | |
| Product outcome | 0.88 | 11.03* | | |
| Complexity | -0.09 | 1.29 | | |
| Control | 0.38 | 5.16* | | |
| Enjoyment | 0.31 | 4.81* | | |
| Complementary on-line services | | | | |
| Visualization | 0.21 | 2.46* | 0.41 | 6.18* |
| Salesperson interaction | 0.10 | 1.14 | 0.15 | 2.28* |
| Product adaptation | 0.15 | 1.77 | 0.20 | 3.01* |
| Range of mass customization options | 0.03 | 0.32 | 0.18 | 2.77* |
| Transaction aspects | | | | |
| Delivery time | -0.02 | -0.27 | -0.11 | -1.79 |
| Price | -2.27 | -7.20* | -2.49 | -10.88* |
| Pseudo $R^2$ | 0.44 | 0.20 | | |

**Table 4. Alternative Models of Intentions to Use On-line Mass Customization.**

*Notes:* $N = 120$. Model estimates based on random coefficient logit model. The pseudo *R*-square expresses the improvement in log-likelihood of the estimated model compared to a baseline model with only the intercept. * Significant at the 95% confidence level.

ceptions were also included. Two important exceptions were visualization and price, which did have direct effects on intentions. The second alternative model included only the on-line mass customization features as independent variables (*see Table 4, Model D*), all of which had significant effects on consumer intentions. Thus, the study found that both mass customization features and cost-benefit perceptions are important drivers of consumer intentions to use on-line mass customization. It also provided support for full mediation by cost-benefit perceptions for the effects of salesperson interaction, product adaptation, range of mass customization options, and the control-variable delivery time, and support for partial mediation for the effects of visualization and the second control-variable price. This latter finding suggests a possible refinement of the originally proposed model to also allow for the direct effects of visualization and price on consumer intentions to use on-line mass customization.

## Discussion

The study found that complementary on-line services enhance consumer intentions to use on-line mass customization. All three complementary on-line

services investigated in the study had significant effects on consumer cost-benefit perceptions. Visualization was the most important of the three, but providing opportunities for salesperson interaction and free product adaptations also increased consumer intentions to use on-line mass customization processes through their effects on consumer cost-benefit perceptions.

A major implication of the study is that on-line retailers may be able to overcome the adverse effects of complexity in mass customization by offering attractive complementary on-line services. These services increase consumer perceptions of product outcome, enjoyment of mass customization, and control. At the same time they lower consumer perceptions of mass customization complexity. Thus, in contrast to the negative effect of increasing the range of mass customization options, adding complementary on-line services to a mass customization offering does not come at the cost of increased complexity to the consumer. Instead, these services reduce perceptions of complexity related to on-line mass customization. This finding should be of great interest to firms offering on-line mass customization, because they will now be able to circumvent the deterrent posed by the complexity of mass customization through ingenious offerings of supporting complementary on-line services. Future research could investigate the potential beneficial effects of other complementary on-line services, such as consumer decision support and recommendation systems, facilitating consumer-to-consumer communication, or offering attractive visual interface formats [3, 45, 50]. Finally, the study also found that the control variables delivery time and price also have significant effects on consumer perceptions of on-line mass customization. This finding suggests that on-line retailers also need to take into account the impact of the more traditional aspects of their customer offering when implementing on-line mass customization processes.

The study has also developed new insights regarding the role of cost-benefit perceptions of on-line mass customization. The results show that cost-benefit perceptions fully mediate the effects of salesperson interaction, product adaptation, range of mass customization options, and delivery time on consumer intentions to use on-line mass customization, and partially mediate the effects of visualization and price. These partial mediation findings suggest that, even though cost-benefit perceptions are the dominant drivers of consumer intentions to use on-line mass customization, to some extent consumers also simultaneously evaluate on-line mass customization processes at the attribute level. The fact that two key attributes (visualization and the control variable price) stand out as attributes that also have a direct effect on consumer intentions to use on-line mass customization may suggest that the most important attributes are more easily taken into account directly in consumers' decisions to use on-line mass customization. As the literature on consumer behavior suggests, less important attributes may be more likely to be grouped cognitively in terms of abstract evaluations of the higher-order costs and benefits of on-line mass customization [12].

As shown by the results, control and enjoyment are important additions to product outcome and complexity in the context of on-line mass customization. Complexity is relatively less important (as a deterrent) in determining consumer intentions to use on-line mass customization than the effects of the

other three variables (all of which are benefits). At the same time, the negative role of complexity should not be ignored, because it has a significant indirect effect on intentions to use on-line mass customization through its impact on consumer perceptions of product outcome and control. Specifically, the effect of complexity on consumer intentions to use on-line mass customization was found to be partially mediated by product outcome and fully mediated by control. The latter finding suggests that when faced with a complex form of on-line mass customization, customers tend to perceive less control, and this reduces their intention to use on-line mass customization. Thus, when offering on-line mass customization, firms need to continue to minimize complexity and aim to increase not just product outcome, but also control and enjoyment.

Some limitations of the study are worth noting and may suggest additional areas for future research. Consumers in the experiment made hypothetical on-line mass customization decision. Although the study used a relevant group of consumers, and took great care was taken to mimic a real-world on-line mass customization scenario, consumer decisions may differ in the real world. This may limit the external validity of the findings. For example, the decision stakes may be higher in real-world mass customization choices, and consumers may be less aware of on-line mass customization opportunities and may not consider on-line mass customization as an option. The fact that perceived complexity did not have a significant direct effect on consumer intentions to use on-line mass customization may perhaps also be explained by the relatively low complexity of the task, or the fact that the respondents were not confronted with an actual mass customization task. Therefore, it would be worthwhile to test the model in a real-world purchase context.

Pseudo-$R^2$ values for the cost-benefit perception models were rather low in the study (*see Table 3*). To further explore the potential cause of this finding, regular fixed-effects regression models were estimated as benchmark comparison models for each of the cost-benefit perceptions. These alternative models have the advantage of imposing less structure on the distribution of the individual specific parameters in the model, but the disadvantage of using many more degrees of freedom and not including random coefficient estimates. The main effect parameter estimates in the fixed effects models were found to be very similar to the estimates in the random coefficient models, while the fit was much higher (ranging from an adjusted $R^2$ of 0.44 for the product outcome model to an adjusted $R^2$ of 0.31 for the control model). Given the high fit of these regular fixed-effect regression models, one may conclude that the impact of the mass customization features on cost-benefit perception is significant and meaningful, but that much of the variation in the cost-benefit perception data was caused by idiosyncratic individual-level differences in perceptions (as captured by the fixed effects).

The present research was also inherently limited by decisions made in terms of application. First, it investigated consumer intentions to use different on-line mass customization processes but did not address the question of how consumers choose between buying on-line and buying from brick-and-mortar retailers. For example, it would be relevant to study the question of how the availability of customization in traditional retail channels would affect consumer intentions to use on-line mass customization. Second, the

empirical analysis focused on on-line mass customization of apparel. While apparel constitutes an important and successful application of actual on-line mass customization, it would be interesting to verify whether the relative importance of different complementary on-line services is consistent across contexts and whether the proposed underlying structure of the model applies equally well to other product categories (e.g., PCs or furniture). For example, the study found visualization to be very important to respondents, but perhaps this result was related to the apparel context of the study. It is likely that visualization of clothing is relatively more important than visualization of other products, such as PCs. Similarly, free product adaptation may not be realistic for all product categories.

Finally, it is worth noting that firms may have different motives for offering mass customization. For example, some firms may do so simply for cost savings or to achieve some type of price discrimination. Such objectives may come at the expense of consumer evaluations of the on-line mass customization process. However, the study focuses strictly on the consumer's perspective on on-line mass customization, and the findings suggest what would be the most attractive on-line mass customization process from the consumer's point of view. Basically it is assumed that most on-line retailers believe in the marketing concept (i.e., meeting consumer needs), especially given the inherently long-term benefits of such an approach to the firm.

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## Appendix A. Example of a Scenario Presented to Respondents

Imagine you are on a company's Web page where it is possible to order your very own pair of customized jeans.

### Scenario/Profile

- The company's Web page offers **14 customization items,** namely, body measurements, fabric, color, fit, leg design, ankle design, waist cut, number of belt loops, number of pockets, pocket design, fly design, hardware, label, and thread.
- After recording the customer's preferences, the company Web page **provides** the customer with a **visualization of the customized product.**
- The company's Web page **offers** every customer the opportunity to have **direct (live) interaction** with a company representative.
- In their **product-alteration policy** the company states that any customer is entitled to **free alterations** if the product does not fit the customer satisfactorily.
- On the Web page it is stated that it will take **2 days** until the customized jeans are **delivered** to your home.
- The **price** of the customized jeans is €30.
- In addition to the jeans-customization option, the Web site **also offers standard-cut jeans.***

* Excluded from further analyses after its effect was found to be not significant.

## Appendix B. Experimental Design

| | Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Scenario (Profile)** | **Visualization** | **Salesperson interaction** | **Product adaptation** | **Range of mass-customization options** | **Delivery time** | **Price** | **Standardized jeans also available** | **Version** |
| 1 | available | available | free | 6 modules | 2 days | €30 | yes | 1 |
| 2 | not available | available | paid | 6 modules | 2 days | €50 | no | 2 |
| 3 | not available | not available | paid | 14 modules | 2 days | €80 | yes | 3 |
| 4 | available | not available | free | 14 modules | 2 days | €120 | no | 4 |
| 5 | not available | not available | free | 6 modules | 7 days | €30 | no | 3 |
| 6 | available | not available | paid | 6 modules | 7 days | €50 | yes | 4 |
| 7 | available | available | paid | 14 modules | 7 days | €80 | no | 1 |
| 8 | not available | available | free | 14 modules | 7 days | €120 | yes | 2 |
| 9 | available | not available | paid | 14 modules | 14 days | €30 | yes | 2 |
| 10 | not available | not available | free | 14 modules | 14 days | €50 | no | 1 |
| 11 | not available | available | free | 6 modules | 14 days | €80 | yes | 4 |
| 12 | available | available | paid | 6 modules | 14 days | €120 | no | 3 |
| 13 | not available | available | paid | 14 modules | 21 days | €30 | no | 4 |
| 14 | available | available | free | 14 modules | 21 days | €50 | yes | 3 |
| 15 | available | not available | free | 6 modules | 21 days | €80 | no | 2 |
| 16 | not available | not available | paid | 6 modules | 21 days | €120 | yes | 1 |

*Note:* Numbers in the table represent the different levels of each variable. Each respondent was presented with four scenarios (or profiles) from one version, to which they were randomly assigned. The order of scenarios within each version was also randomized.

## Appendix C. Scale Items

### *Product outcome (adapted from [75])*

1. The jeans that I would be able to create, based on the scenario, are more attractive than competing standard-cut jeans (factor loading fixed to 1.00).
2. The product given in the scenario provides a superior quality-to-cost ratio compared to standard-cut jeans (factor loading 0.83, *t*-value 8.22).

### *Complexity (adapted from [13, 14])*

Using the procedure for product customization as portrayed in the scenario,

1. will be complicated (factor loading fixed to 1.00).
2. will be confusing (factor loading 0.95, *t*-value 19.89).
3. will take a lot of effort (factor loading 0.73, *t*-value 14.16).
4. will require little work (factor loading 0.38, *t*-value 4.49).**

### *Control (adapted from [13])*

1. I am satisfied with the amount of control I have over the customization process provided in the scenario (factor loading fixed to 1.00).
2. The customization process, portrayed in the scenario, will give me control over designing my own clothes (factor loading 1.03, *t*-value 13.39).

### *Enjoyment (adapted from [13, 14])*

Being able to customize my clothing as described in the scenario,

1. will be interesting (factor loading fixed to 1.00).
2. will be entertaining (factor loading 1.09, *t*-value 27.29).
3. will not be fun (factor loading 0.82, *t*-value 12.86).**
4. will be enjoyable (factor loading 0.94, *t*-value 18.52).

### *Intention to use*

If a mass customization option, as described in the scenario, was available to you, would you make use of it?

*Note:* All scales (except intention to use) used a seven-point Likert-type scale (1= strongly agree, 7 = strongly disagree). The intention-to-use scale was a yes-no binary response. ** Reversed scale.

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