Consumer decision quality in mass customisation

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Abstract: Product configuration is a key enabling process in mass customisation that allows customers to choose their products based on choice of product attributes. Product configuration is significantly different from the traditional process, commonly known as product selection, which focuses on the choice of product alternatives. This paper reports an experimental investigation of differences between product configuration and product selection in terms of consumers' decision quality. The results show that product configuration offers customers greater satisfaction during the process and in the products of their choices than product selection. Interacting factors such as how the product attributes or alternatives are presented and the number of products on offer has also been studied. Results enhance the development of mass customisation enabling technologies.

Keywords: product configuration; product selection; customer decision making; customer satisfaction.

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1 Introduction

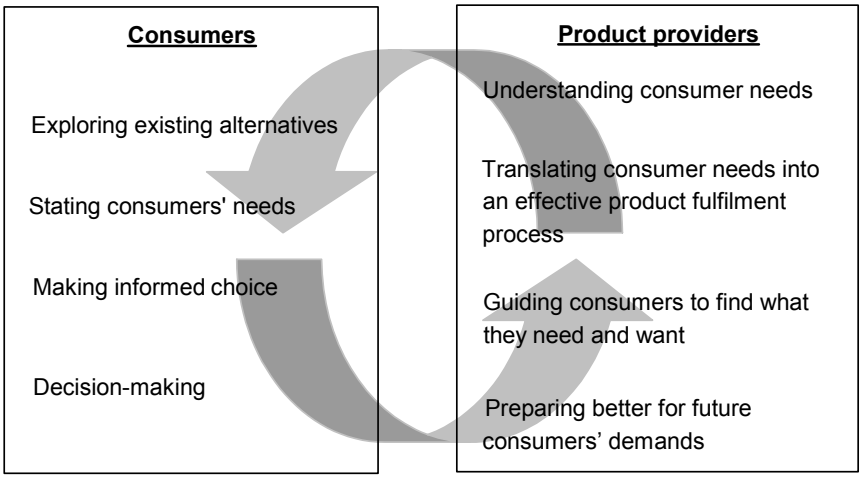
1.1 Mass customisation

Customers make their purchasing decisions in typical buying processes, after examining and comparing different product alternatives and their selections are limited to the merchandise placed in front of them. This conventional buying process forces customers to compromise and compensate for bad product attributes by using good attributes in the same product. Customers have to 'take it or leave it' because they have no option to change the product attributes. If customers do not want to compromise, then they have to abandon their purchase and the shops will lose customers.

Manufacturers have the abilities and the opportunities to provide a more flexible and direct service to the consumers of their products with the advances in manufacturing technology and the availability of low-cost communication networks (*e.g.*, the internet). The result is a new style of purchasing behaviour that facilitates the direct interactions between manufacturers and consumers to explore the capability of product providers, specify the purchasing needs, make tradeoffs, and make informed decisions. This new style of purchasing behaviour puts the consumers in the centre of the manufacturing systems so that customers' interests can be satisfied without a large inventory and consumers' laborious search of mismatched products.

This type of new buying process, though seemingly straightforward, requires a new set of under-pinning models to facilitate the interactions between the product providers and the consumers. On one hand, the consumers need to be informed of possibilities, *i.e.*, the product providers' capability for making the products, and their economics. On the other hand, the product providers have to understand consumer needs, translate them into a set of manufacturing requirements, and provide the information precisely to consumers. Then the negotiation between the product providers and consumers will be an iterative give-and-take process. Most importantly, the entire process has to be carried out without using technical jargon and at the same level of consumers' cognitive processes. This interactive process between consumers and product providers involves two-way explorations. On one hand, consumers explore product alternatives as well as attributes to learn what is available, state their needs, and make informed decisions. On the other hand, product providers learn about their consumers, translate the consumer needs into product fulfillment processes, guide consumers in finding what they want, and prepare for future demand. This interaction process is summarised in Figure 1.

Figure 1 A summary of activities during direct interactions between consumers and product providers



Mass customisation is an enabling concept that facilitates the process of best fulfilling individual consumer needs with near mass production efficiency (Tseng and Jiao, 1997). Providers, in realising mass customisation, have to gather information about individual consumer's needs and respond to him or her with the appropriate product information timely and efficiently.

Product configuration has been generally accepted as a means to specify a product from its subsystems and attributes, either by selection, modification, or unique design for the consumers to express their needs. The purpose is to best satisfy individual needs with respect to manufacturer's capabilities. Requiring consumers to modify and design product attributes increases the cognitive and physical demand on the consumers. If the consumers' choices are not conducive to economy of scale, then it may also increase the manufacturing cost. Research is being carried out to optimise the desire of the consumers, the workload of the consumers, and the manufacturing cost (*e.g.*, Guillabert and Donthu, 2003; Dellaert and Stremersch, 2003). This paper focuses on the use of product attribute selection to facilitate mass customisation. The rest of the paper's scope is product configuration that is limited to the selection of product attributes. The product configuration process has been recognised as a key enabler of mass customisation (Bourke, 2001). Also, web interfaces have been recognised as a very effective means to facilitate the configuration process. This process is normally supported by a software programme, which can define and manage a unique variant of a product.

1.2 Challenges in studying the behaviour of consumers while customising products

Understanding consumers is crucial to the successful implementation of the mass customisation. A research question posted by Franke and Piller (2003) – in tackling the problem from the consumer's perspective – concerned "how to understand customisation from the consumer's point-of-view". This includes questions such as how consumers handle choices, how to study consumers' experience with the customisation process, and

what factors in mass customisation will affect consumers' satisfaction. Relatively few studies have been conducted in this area despite the importance of understanding the issue (Franke and Piller, 2003; Dellaert and Stremersch, 2005).

Consumers are faced with choices of attributes (*e.g.*, colour and shapes, *etc.*) and their levels (*e.g.*, blue, white or black colour and round, triangular or rectangular shapes) during a configuration process. Consumers need to select a level for each attribute and combine them into a product. This process is different from the usual buying process where consumers merely select a product among competing alternatives. The quality of decisions made during product configuration and product selection processes has been studied to address the research question posted by Franke and Piller (2003) on how to understand the process of mass customisation and is presented in this paper. A review of literature on decision quality is presented in the next section.

2 Decision quality

The process of how people make preferential choices among alternatives has been studied extensively in the fields of psychology and economy for more than four decades. Between the 1950s and the 1980s, the process of making choices among alternatives, referred to as the decision-making process, was studied and modelled as trade-off processes based on sets of predetermined preferences (*e.g.*, Simon, 1955; Svenson, 1979; Tversky and Kahneman, 1988). Since the 1980s, researchers in the field favoured the approach of modelling the DMP as an adaptive information process in which consumers will construct their trade-off strategies according to their interactions with the environment (*e.g.*, the 'constructive consumer choice processes': Bettman *et al*., 1998). The decision results, such as product accuracy, mental effort and decision errors, have also been a subject of interest in this field (*e.g.*, Bettman *et al*., 1990; McFadden, 1999).

Experimental techniques in presenting the tasks and measuring the decision process were adapted in this study from past literature (Payne, 1976; Olshavsky, 1979). A preliminary experiment was conducted to repeat some of the major findings of past research in product selection (Kurniawan *et al*., 2000). The results of the preliminary study indicated that our experimental setting with Hong Kong Chinese participants was able to reproduce the past findings in Payne (1976), Olshavsky (1979), and Johnson and Payne (1985). The result of Kurniawan *et al*. (2000) strengthens the general validity of studies by Payne (1976), Olshavsky (1979), and Johnson and Payne (1985) and provided an important link between this study and the past work by Professors Payne and Olshavsky.

Previous research on product selection uses measures of product accuracy and mental effort to quantify the quality of consumer's decisions. One of the assumed goals in product selection has been to obtain higher product accuracy while using as little effort as possible (Johnson and Payne, 1985; Payne *et al*., 1993; Bettman *et al*., 1998). Product accuracy refers to the closeness between consumers' preferences on the product that they would like to buy and the products that they have actually bought. It has been assumed that consumers have certain preferences on product attributes before the product selection process, and would like to select a product that best matches their initial preferences (Payne *et al*., 1993). The assumption of an invariant preference was challenged by Bettman *et al*. (1998) who argued that consumers do not necessarily need an initial

preference on what they want and could construct this preference during the product selection process (*i.e.*, the 'constructive consumer choice processes'). Product accuracy in this study is defined as the closeness between the selected product and the preferred product at the end of the product selection process. This definition avoids the argument on whether the preference stays invariant during the product selection process. Bettman *et al*. (1990) defined the mental effort in product selection as the cost of thinking in making a decision. One method to measure this mental effort is to conduct a detailed task analysis on all activities performed by each participant during the product selection process so that the whole process is broken down into a sequence of basic activities called Elementary Information Processes (EIPs). Examples of EIPs included reading information, comparing two pieces of information, subtracting and adding, switching attention, eliminating and choosing an alternative. A final index is calculated when the tallies of these EIPs are multiplied by their appropriate levels of mental effort and summed. Bettman *et al*. (1990) used the EIP methodology to measure and compare the mental efforts needed as functions of different product selection strategies. It was found in that study that the mental effort measured by the EIP index was correlated to the amount of information searched by the participants during the product selection processes and the total time spent. Consequently, a simpler method to measure the mental effort of a consumer is to measure the amount of information searched by him or her as well as the total time spent. The use of time spent and the total amount of information searched to quantify the mental effort is also consistent with the classical study on product selection (Olshavsky, 1979). In this study, both the time spent and the amount of information searched during the product selection or configuration processes are measured.

Consumer satisfaction can also be a measure of decision quality besides the mental effort and selection accuracy. Two important aspects of the overall consumer satisfaction are:

1 the level of satisfaction associated with the final chosen product (*e.g.*, Day, 1984; Spreng *et al*., 1996)

2 the level of satisfaction associated with the purchasing process (*e.g.*, Arnould and Price, 1993; Oliver, 1993).

The former has been referred to as the product satisfaction and the latter has been referred to as the process satisfaction. The product satisfaction can be measured in two aspects:

1 a holistic satisfaction towards a chosen product (Spreng *et al*., 1996)

2 the specific levels of satisfaction towards the product attributes (Oliver, 1993).

A typical means to evaluate product satisfaction is to measure rated consumers' affective responses to the selected products (Cole and Balasubramanian, 1993; Westbrook, 1987; Mano and Oliver, 1993; Westbrook and Oliver, 1991). Similarly, a typical means to evaluate process satisfaction is to measure rated process satisfaction (*e.g.*, Arnould and Price, 1993; Campbell, 1997; Fisher and Price, 1991; Oliver, 1993).

Decision quality with product selection has been the subject of many studies and has been defined to include the following aspects:

- product accuracy: closeness between preferred product and the product that is actually bought or selected
- product satisfaction: satisfaction related to the product that is selected
- process satisfaction: satisfaction related to the buying or selection processes
- mental effort: cost of thinking in making decisions, normally measured by the total time spent and the amount of information searched during the product selection process.

Similar research on product configuration has received little attention, although the decision quality related to product selection has been studied extensively.

3 Method and design of experiment

The goal of the experiment is to investigate decision quality in the product configuration process. Decision quality with product selection process has been the subject of many studies while similar studies with product configuration are few. Decision qualities in this study associated with both processes are studied so that the new knowledge acquired with the product configuration process is anchored relative to the existing body of knowledge concerning product selection. Decision quality – according to the review of the literature reported in Section 2 – is measured using the following items:

- consumer satisfaction on the final products of their choices
- consumer satisfaction on the process
- closeness between the products of their choice and their preferred product (*i.e.*, product accuracy)
- time spent in product selection or configuration processes
- amount of information searched.

3.1 The task, independent and dependent variables

Participants in this study were asked to shop for the T-shirts of their choices on a web-store and they would receive the chosen T-shirts at the end of the experiment. The experiment had three independent variables and each variable had two levels:

1 mode of presenting the product choices (by attribute or by alternative)

2 shopping method (by product configuration or by product selection)

3 number of possible product alternatives offered (16 or 256 products).

The experiment consisted of eight conditions that were exhaustive combinations of the three independent variables. The eight combinations are illustrated in Table 1 with brief descriptions.

Table 1 Brief task descriptions of the eight combinations of the three independent variables: (a) mode of choice representation, (b) shopping method, and (c) number of products offered

	Choice representation			
	By attribute		*By alternative*	
Shopping method	*16 products*	*256 products*	*16 products*	*256 products*
By configuration	Configuration tasks showing levels of different product attributes and one configured product alternative (see Figure 2). Participants searched, selected, and combined different levels of product attributes to configure a product alternative. This is the most typical form of product configuration.		Configurations task showing levels of different product alternatives and provide the possibilities to change levels of product attributes (see Figure 3). Although participants still can configure a product alternative by changing its attributes, they were denied seeing all the levels of product attributed at a glance.	
By selection	Selection tasks with the benefits of seeing all the levels of product attributes at a glance but participants still had to search through the product alternative domain but with the help of a search tree organised from the product attribute point-of-view (see Figure 4).		Selection tasks showing different product alternatives (see Figure 5). Participants searched and selected different product alternatives. This is the most typical form of product selection.	

The four quadrants in Table 1 represent the exhaustive combination of the shopping methods and the mode of presenting choices. The upper-left and the lower-right quatrains in Table 1 represent the typical product configuration and product selection tasks with the former presenting choices of product attributes and the latter presenting choices of product alternatives. The mode of choice presentation was studied as one of the independent variables to isolate the confounding effects of shopping method and mode of choice presentation. Snapshots of the web-stores used to implement the four combinations of shopping method and mode of choice presentation are shown in Figures 2 to 5. Each of these four combinations was studied with two levels of stocks (16 and 256 product alternatives). The product selection interfaces – as shown in Figures 4 and 5 – include a search tree designed to help the participants to navigate through the selection of front picture and sleeve colour. The tree only covers two attributes because if it covered all four attributes, the participants could then configure their product alternatives using the tree and the product selection interfaces would become just another product configuration interface. These two attributes were selected because participants rated these two attributes as more important than the other two attributes in the pre-experiment questionnaires.

Figure 2 A snapshot of the web-based store offering 256 T-shirts, supporting product configuration and presenting choices by product attributes

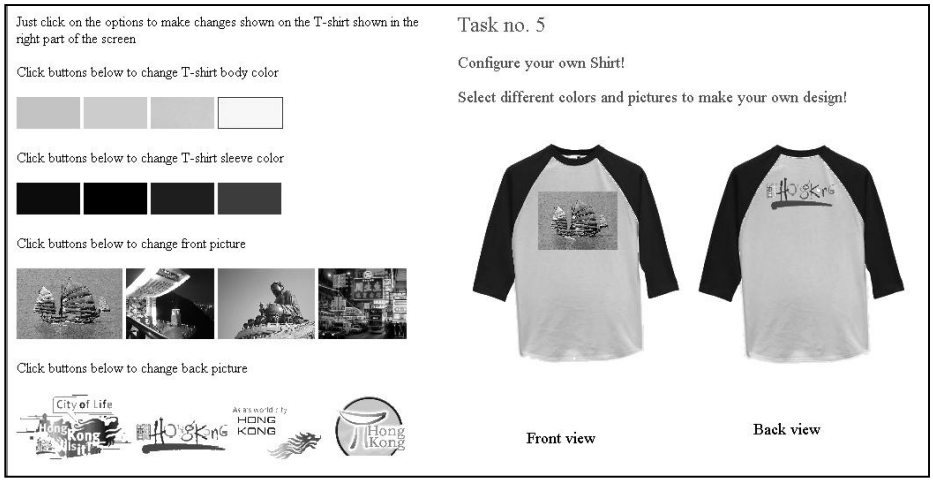


Figure 3 Three snapshots of the web-based store offering 256 T-shirts, supporting product configuration and presenting choices by product alternatives

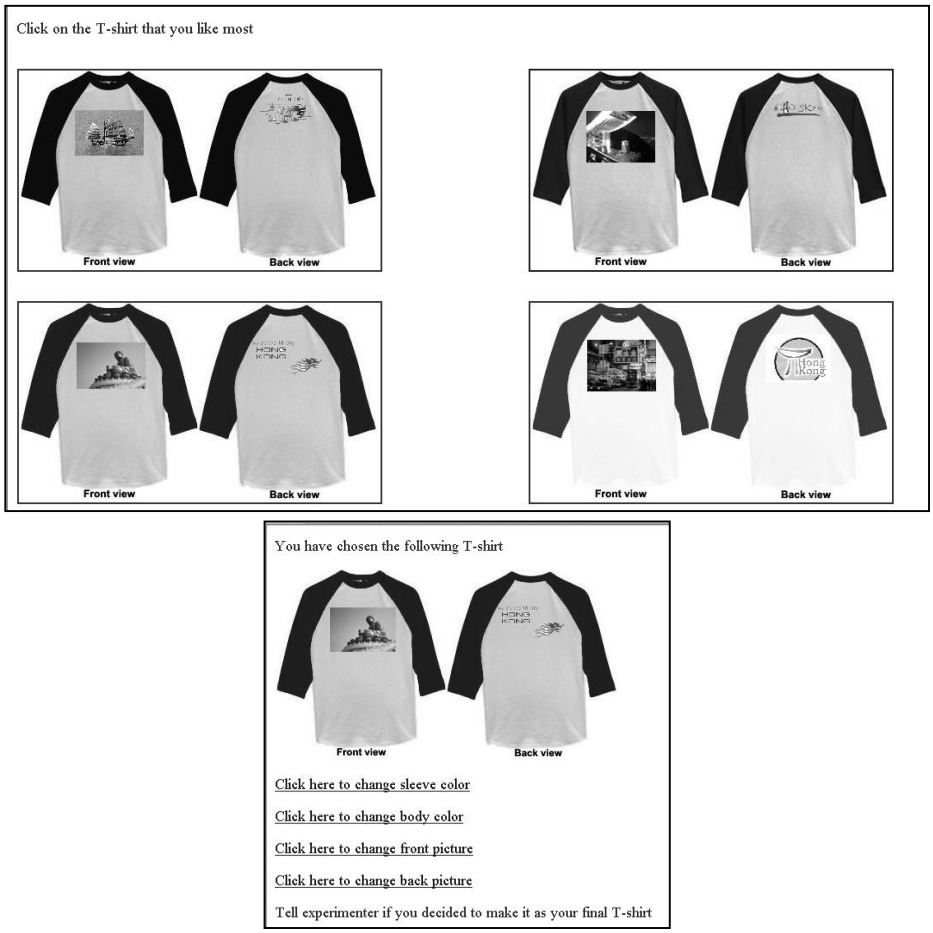


Figure 3 Three snapshots of the web-based store offering 256 T-shirts, supporting product configuration and presenting choices by product alternatives (continued)

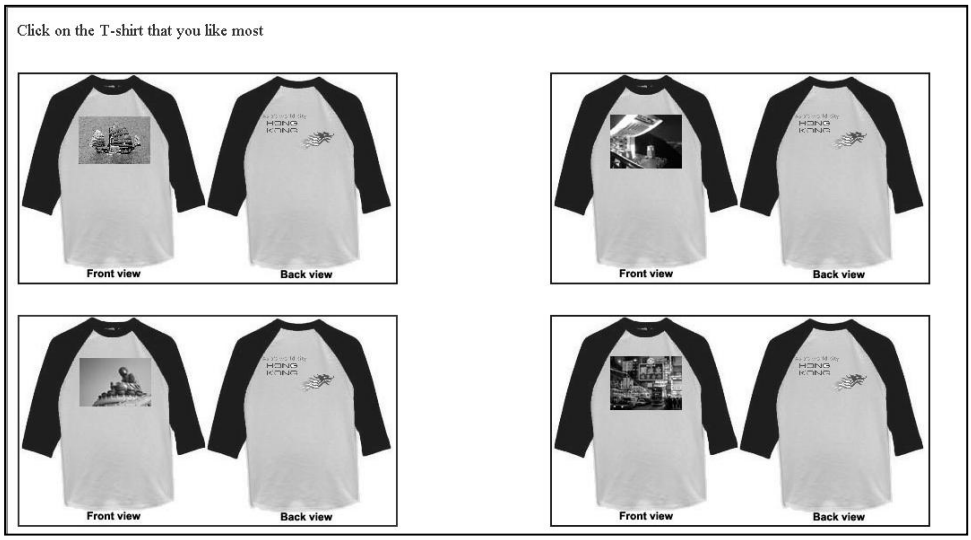


Figure 4 A snapshot of the web-based store offering 256 T-shirts, supporting product selection and presenting choices by product attributes

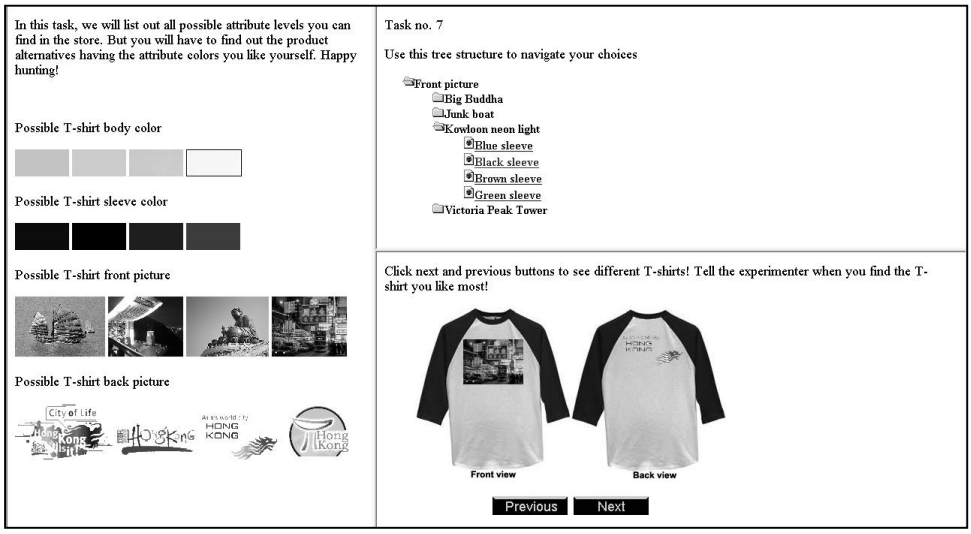
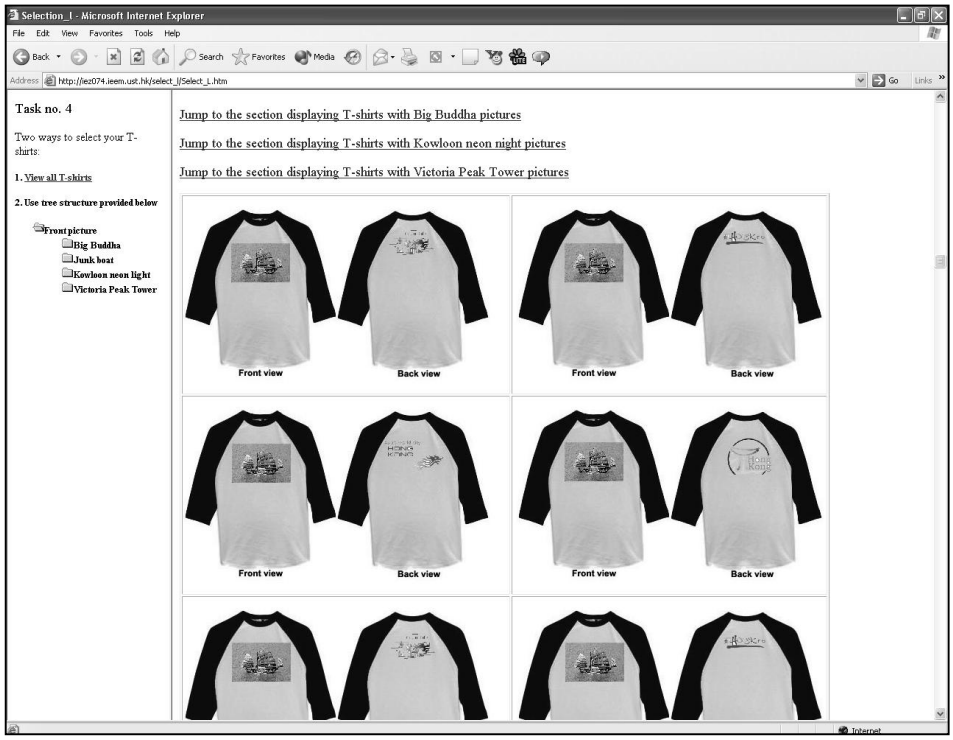


Figure 5 A snapshot of the web-based store offering 256 T-shirts, supporting product selection and presenting choices by product alternatives



Six dependent variables were measured in this study and they were used to quantify the decision quality associated with the shopping experience:

1 Consumer satisfaction with the chosen product. Rated levels of product satisfaction were measured using a seven-point Likert scale originally developed to measure satisfaction with brand selection (Cole and Balasubramanian, 1993).

2 Consumer satisfaction with the shopping process. Rated levels of process satisfaction were measured using a seven-point Likert scale originally developed to measure satisfaction with shopping activity (Fisher and Price, 1991).

3 Closeness between the preferred product and the chosen product (*i.e.*, product accuracy). This item was measured using a seven-point Likert scale developed to measure disconfirmation (Spreng and Olshavsky, 1993). The scale ranges from 'Worse than I expected' (scale 1) to 'Better than I expected' (scale 7).

4 Number of product alternatives searched before making a decision. The number of product alternatives searched was measured using recorded histories of mouse click; video recordings of the computer screen, and voice recording of the participants when they were 'thinking-aloud'. All participants were trained to speak out what they were thinking during the experiments (*i.e.*, the 'think-aloud' technique). Only product alternatives that were browsed, examined, compared, configured, eliminated, or selected were counted. Visual examination or even elimination of certain levels of product attributes was not counted towards this number.

5 Time spent. The time spent was the period between the moment when a participant began a shopping task until he or she made the final decision on the chosen T-shirt.

6 Average time spent per product alternatives searched. It is measured by dividing the total time spent (*i.e.*, Item 5) by number of product alternatives searched before making a decision (*i.e.*, Item 4). The authors acknowledge that this measurement could carry biases and should be carefully interpreted because examination of product attributes was not counted.

3.2 Hypotheses

Nine hypotheses were formulated to predict the relationships between each independent variable and decision quality. These hypotheses are:

- Presenting the choices by product attributes will lead to higher process satisfaction (H1a) and shorter total time spent (H1b) than presenting the choices by product alternatives.
- Choosing the products by product configuration will lead to higher process satisfaction than product selection (H2a) and shorter total time spent (H2b) and lesser number of product alternatives searched (H2c).
- The effects of changing the number of product choices will have significant interaction effects with the effects of shopping methods (H3a) and mode of presentation (H3b).

An increase in the number of choices will particularly increase the differences in process satisfaction collected with the use of product configuration and product selection (H3c). An increase in the number of choices will similarly increase the differences in process satisfaction collected with the use of alternative-based and attribute-based presentation methods (H3d). The rationales for formulating these hypotheses are explained in the next few paragraphs.

Bettman and Kakkar (1977) reported that the format of displaying product information can affect the decision processes of shoppers. Information processing (*e.g.*, search, compare, elimination) and decisions were conducted at the levels of product alternatives, particularly when decision-makers were presented with product alternatives. On the other hand, when the format of information display was changed to product attributes, information processing and decisions were conducted at the levels of product attributes. The number of different product attributes is much smaller than that of product alternatives because a product alternative is a particular permutation of product attributes for the same number of product choices. Consequently, Bettman and Kakkar's (1977) findings suggest that the amount of information processing (*e.g.*, search, compare, eliminate) will be much less with attribute-based presentation format than alternative-based presentation format. It is, therefore, hypothesised that presenting choices in an attribute-based format will increase levels of satisfaction with the decision process and lead to shorter processing time, as compared with presenting choices in an alternative-based format (Hypotheses H1a and H1b).

Consumers have to construct their own products by combining selected levels of product attributes in product configuration. Kamali and Loker (2002) reported that consumers became more satisfied after they had spent effort in building their own

products. Consequently, it was hypothesised that participants could give higher process satisfaction ratings after product configuration than after product selection (H2a). This hypothesis is consistent with the finding that consumers' emotion, their needs for fun and pleasure, as well as hedonic experiences can influence the levels of consumer satisfaction (Addis and Holbrook, 2001). Consumers also focus on the hedonic and experiential aspects of consumption when they configure and customise their products. Such experience has been shown to make the experience of shopping more compelling (*e.g.*, Addis and Holbrook, 2001; Novak *et al*., 2000) as well as increase the personal attachment with the chosen products (Pine, II and Gilmore, 1999). The use of product configuration instead of product selection as the shopping method should increase the levels of process satisfaction (*i.e.*, Hypothesis H2a).

Product choice serves two purposes:

1 Offering product choices enable product providers to increase the probability of providing the right products to their consumers.

2 The choices can also help consumers to visualise and realise their preferences so that they can choose the most preferred product among available choices.

Too many choices may have drawbacks while choices help in connecting and matching consumers' preferences and product providers' design and manufacturing capabilities (Miller, 1956). Previous research has found that consumers can be overloaded with information when presented with too many product choices (Payne *et al*., 1993). Research in decision-making has found that people will adopt strategies to reduce the number of choices as the number of product alternatives increases, until the remaining number of choices was within certain ranges (Kurniawan *et al*., 2000; Payne, 1976; Olshavsky, 1979; Onken *et al*., 1985). This suggests that consumers will prefer a shopping method that allows them to effectively search through the choices when the number of choices is large (Huffman and Kahn, 1998). It was hypothesised that when the number of choices is large, the method of product configuration can facilitate a more effective way to search through the choices than the product selection method and when the number of choices is small, the differences in effectiveness associated with the two methods are reduced. Consequently, effects of number of choices were hypothesised to have interactions with the effects of shopping methods (H3a and H3c). Similarly, it was hypothesised that when the number of choices is large, presenting the choices by product attributes is a more effective way to present the information. This leads to hypotheses H3b and H3d.

3.3 Participants and task assignment

Forty-eight Hong Kong Chinese university students participated in the experiment. They were instructed to configure and select T-shirts for themselves. The chosen T-shirts were given to them as rewards. All participants had prior experience in shopping for T-shirts. The task sequence was randomised. A within-subject, full factorial design was used and each participant was asked to do all eight tasks.

4 Results and data analyses

The data was tested for distributions. ANOVAs were conducted for all dependent variables while non-parametric Wilcoxon signed ranked tests were also conducted for those without normal distributions to confirm the results. Significant main effects were only reported if the main effects were confirmed with non-parametric tests for data whose distributions did not follow normal distribution.

Tests of Cronbach alpha indicated that the questionnaires used to measure levels of process and product satisfaction were internally consistent with alpha values of greater than 0.7. No significant difference was found among all the dependent variables collected from male and female participants (all *p*-values > 0.1). A possible explanation is because the tasks assigned to participants were simple and the types of T-shirts offered were not oriented to a specific gender. Data from both genders was combined in the subsequent analyses.

4.1 Effects of mode of presenting choices

Compared with presenting choice by alternative, presenting choice by attribute significantly increased levels of process satisfaction (W(191), Z = –2.421, $p < 0.05$, Wilcoxon signed ranked tests) but did not affect levels of product satisfaction (W(191), Z = –1.82, $p > 0.05$) and product accuracy (W(191), Z = –1.392, $p > 0.1$). When presenting choices by attribute, participants searched significantly less product alternatives (W(191), Z = –7.667, $p < 0.0001$) and required significantly less time before choosing the final product (W(191), Z = –3.074, $p < 0.01$). They did, however, spent longer time on each product searched (W(191), Z = –5.09, $p < 0.0001$). These data support both hypotheses H1a and H1b.

4.2 Effects of shopping methods

Shopping by product configuration was associated with significantly higher process satisfaction (W(191), Z = –9.936, $p < 0.0001$), higher product satisfaction (W(191), Z = –9.026, $p < 0.0001$), and higher product accuracies (W(191), Z = –5.093, $p < 0.0001$). Shopping by configuration also led to lesser total shopping time (W(191), Z = –6.329, $p < 0.0001$) but resulted in longer time spent per product searched (W(191), Z = –5.772, $p < 0.0001$) because the number of product searched was much reduced (W(191), Z = –9.321, $p < 0.0001$). These data support hypotheses H2a, H2b, and H2c.

4.3 Effects of number of choices

Increasing the number of choices from 16 to 256 significantly increased levels of process satisfaction (W(191), Z = –5.511, $p < 0.0001$), product satisfaction (W(191), Z = –5.822, $p < 0.0001$), and product accuracies (W(191), Z = –6.494, $p < 0.0001$). This suggests that increasing the number of choices from 16 to 256 significantly affected the shopping and decision processes of the participants.

4.4 Two-way interaction effects

Significant interactions were found between the effects of increasing the number of products and the effects of using different shopping methods on both product satisfaction ($F(1,376) = 1.893$, $p < 0.05$, ANOVA) and process satisfaction ($F(1,376) = 13.966$, $p < 0.0001$, ANOVA). This supports hypothesis H3a. The interaction plots indicate that as the number of product increased, the benefits of product configuration increased (Figures 6 and 7) and this finding supports Hypothesis H3c.

Figure 6 A two-way interaction plot illustrating the interactions between the effects of the number of product choices and the change of shopping methods on product satisfaction ratings. Mean data of 48 participants are shown

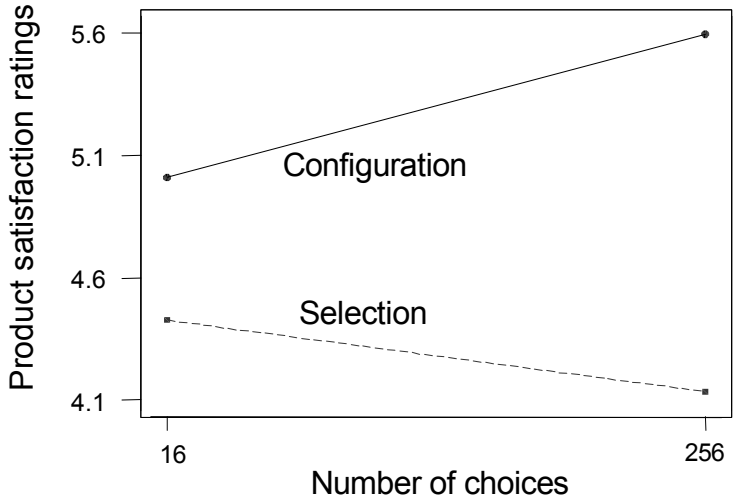
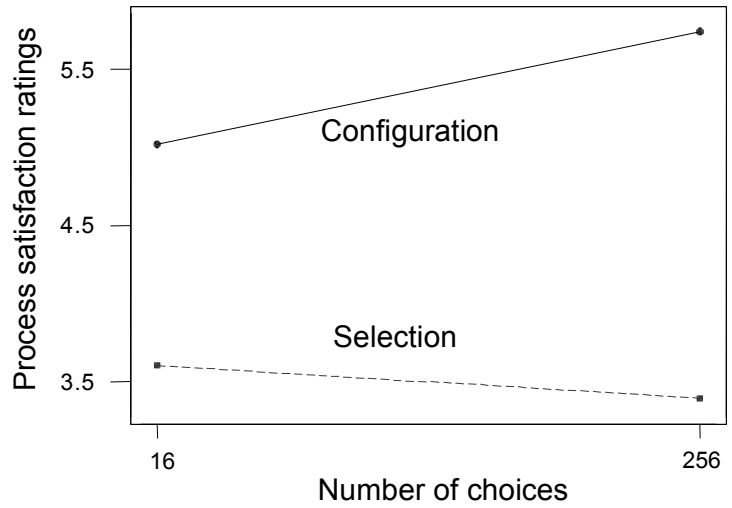


Figure 7 A two-way interaction plot illustrating the interactions between the effects of the number of product choices and the change of shopping methods on process satisfaction ratings. Mean data of 48 participants are shown



To our surprise, no significant interaction was found between the effects of the number of choices and the effects of the mode of presentation on neither product satisfaction ($F(1,376) = 0.001$, $p > 0.9$) nor process satisfaction ($F(1,376) = 1.642$, $p > 0.2$). This disagrees with hypotheses H3b and H3d. Significant interactions were found between the effects of presentation mode and the effects of shopping method on both product satisfaction ratings ($F(1,376) = 4.447$, $p < 0.05$, ANOVA) and process satisfaction ratings ($F(1,376) = 51.911$, $p < 0.0001$). Their interaction plots indicate a trend reversal on the effects of choice presentation as the shopping method changed from selection to configuration (Figures 8 and 9). For example, presenting the choices in terms of attributes significantly increased the rated process satisfaction during product configuration ($W(95), Z = –6.523$, $p < 0.0001$) but significantly reduced the process satisfaction ratings during product selection ($W(95), Z = –2.828$, $p < 0.01$). One possible explanation is that there was a compatibility issue between the mode of choice presentation and the shopping method. Results suggest that presenting the choices by attributes is more compatible with product configuration while presenting choices by alternatives is more compatible with product selection.

Figure 8 A two-way interaction plot illustrating the interactions between the effects of the presentation mode and the change of shopping methods on product satisfaction ratings. Mean data of 48 participants are shown

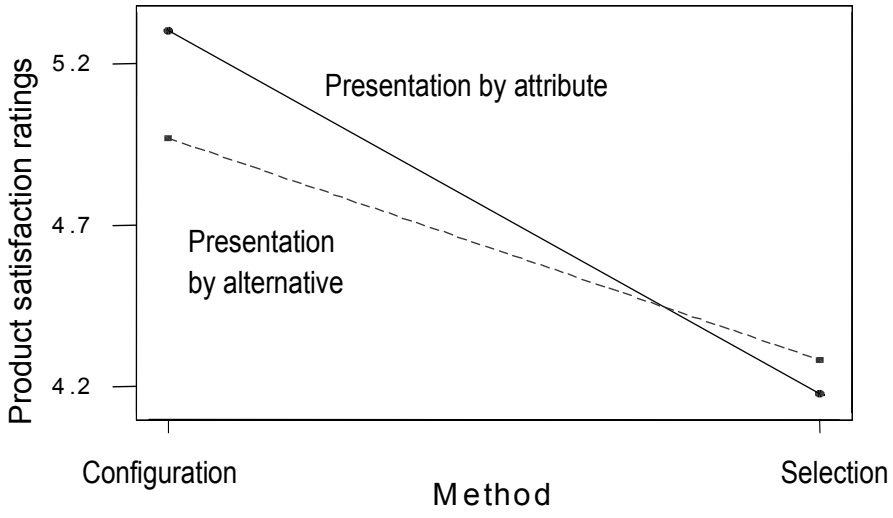
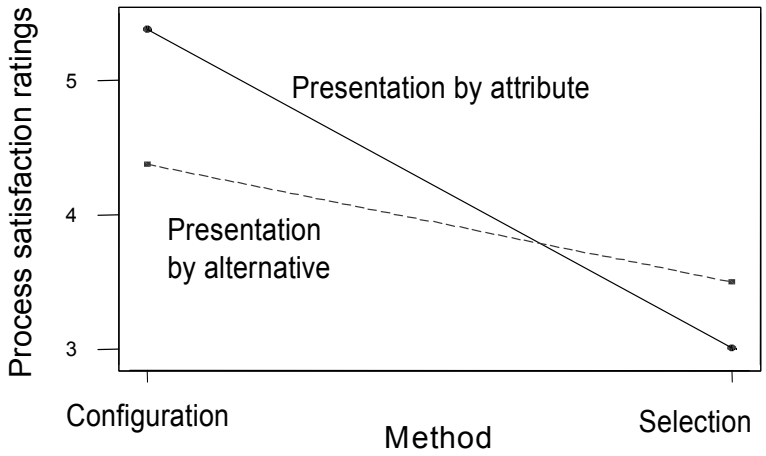


Figure 9 A two-way interaction plot illustrating the interactions between the effects of the presentation model and the change of shopping methods on process satisfaction ratings. Mean data of 48 participants are shown



5 Discussion

Results of this study indicated that shopping by product configuration method can increase the decision quality in terms of significant increases in rated levels of product accuracies, process satisfaction, and product satisfaction ($p < 0.0001$, Wilcoxon signed ranked tests). Participants, using the configuration method, also required significantly less time and searched significantly fewer product alternatives before reaching their final decisions ($p < 0.0001$, Wilcoxon signed ranked tests). The results suggest that configuring products instead of selecting products can achieve higher decision quality with less mental effort because the amount of information searched and total time spent have been found to correlate with metal effort (see Section 2). This finding, proven statistically, is important because product configuration is a common facilitating tool for implementing mass-customisation. Franke and Piller (2003) stated that it is important to understand customisation from the customer's point-of-view. In this study, product configuration has been shown to be a better shopping method than product selection. Exploring the reason(s) for the supremacy of product configuration would be an interesting and relevant question. A comparison of the user interfaces between the typical product configuration condition (*i.e.*, configuration with attribute-based choice presentation: Figure 2) and the typical product selection condition (*i.e.*, selection with alternative-based choice presentation: Figure 5) reveals two main differences from the customers' point-of-view (see Table 2). The benefits of displaying attribute information have to be isolated (Table 2) to confirm the benefits of product configuration as a means of shopping. This is achieved by analysing the results obtained with the condition in which attribute information was displayed on a product selection interface (Figure 4). The interaction plots shown in Figures 8 and 9 indicate that adding tabulated attribute information to the product selection interface did not increase decision quality in terms of product and process satisfaction ($p < 0.01$, Wilcoxon signed ranked tests). This suggests

that the supremacy of the typical product configuration interface (Figure 2) over the typical product selection interface (Figure 5) was mainly due to the change of shopping method and not due to the presentation of attribute information. This argument is further substantiated by the significant improvement in product satisfaction ratings when the typical product selection interface (Figure 5) was changed to a product configuration interface without displaying attribute information (Figure 3) ($p < 0.001$, Wilcoxon signed ranked test).

Table 2 Observed differences between the typical product configuration condition (Figure 2) and the typical product selection condition (Figure 5)

	Typical product configuration presenting attribute information (Figure 2)	*Product selection presenting attribute information (Figure 4)*	*Typical product selection presenting alternative information (Figure 5)*
Information presentation	All the levels of product attributes are tabulated and shown	All the levels of product attributes are tabulated and shown	Only the levels of the most important two attributes are shown in the form of a search tree
Means of shopping	Construct a product alternative by choosing appropriate combinations of attributes	Navigate through a tree and then browse through product alternatives to find the appropriate alternative	Navigate through a tree and then browse through product alternatives to find the appropriate alternative

The supremacy of product configuration over product selection holds for both conditions with 16 and 256 products, although the effects of shopping method have been shown to have significant interactions with the effects of number of choices on both product and process satisfaction ratings (see Figures 6 and 7). Further investigations on the significant interactions indicate that an increase in number of choices is likely to increase the supremacy of product configuration (see Section 4.4). This finding further demonstrates the benefits of using product configuration as a shopping method to facilitate mass-customisation because the number of possible products on offer in a mass-customisation business can be very large.

6 Conclusion

This paper reported the results of a study investigating decision quality in mass-customisation shopping websites with product configuration as a facilitating process. Data suggests that using product configuration instead of product selection as a facilitating method in mass-customisation businesses can result in higher product and process satisfaction ratings, higher rated product accuracies, as well as lower mental workload as indicated by quicker decisions and less time allocated to information searching before the final decision. The increases in rated levels of product and process satisfaction when product configuration is used instead of product selection hold when the total numbers of product choices are 16 and 256. Analyses of the interaction effects suggest that an increase in the number of choices from 16 to 256 can further enhance the benefits of using product configuration in terms of higher product and process satisfaction.

The effects of presenting all the product attribute information in a single table have been isolated from the effects of using product configuration instead of using product selection. Results suggest that the presentation of tabulated attribute information alone cannot explain the supremacy of product configuration over product selection. This indicates that the process of configuring a product itself contributes to its benefits over product selection. Further work on the decision-making process and strategies during product configuration is recommended.

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