Sales Configurator Capabilities to Prevent Product Variety from Backfiring

Alessio Trentin and **Elisa Perin** and **Cipriano Forza**[1]

Abstract. Firms offering high product variety and customization can paradoxically experience a loss of sales because customers feel overwhelmed by the number of product configurations offered. Sales configurators may be a solution for avoiding this paradox, but relatively few studies have focused on the characteristics they should have in order to overcome this problem. Furthermore, empirical investigation on the effectiveness of the recommendations made by these studies has been hindered by the lack of psychometrically sound measurement items and scales. This paper conceptualizes, develops and validates five capabilities that sales configurators should deploy in order to avoid the product variety paradox: namely, focused navigation, flexible navigation, easy comparison, benefit-cost communication, and user-friendly product-space description capabilities. The measurement instrument is hoped to support advancements in both research and practice.

1 INTRODUCTION

Many firms in diverse industries are increasing the product variety and customization offered to their customers [1-3]. By giving customers exactly what they want, or at least something closer to their ideal product solutions, companies expect to gain higher market shares and/or to be able to charge higher prices [4, 5], thereby increasing revenues.

There is a risk, however, that a strategy of product proliferation and customization backfires, leading to lower rather than greater revenues, as increasingly suggested in literature [5-11]. Potential customers, for example, may feel so confused and overwhelmed by the number of product configurations offered by a company that they choose not to make a choice at all [6] and the company loses potential sales. Firms offering product variety and customization may therefore experience what has been termed the "product variety paradox" [12]: offering more product variety and customization in an attempt to increase sales paradoxically results in a loss of sales.

An important role in alleviating the risk of experiencing this paradox can be played by sales configurators [12-14]. A sales configurator is a subtype of software-based expert systems (or knowledge-based systems) with a focus on the translation of each customer's idiosyncratic needs into complete and valid sales specifications of the product solution that best fits those needs within a company's product offer [15, 16]. The fundamental functions of a sales configurator include presenting a company's product space, meant as the set of product solutions that a firm offers [17], and guiding customers in the generation or selection of a product variant within that space, thus preventing inconsistent or unfeasible product characteristics from being defined [14, 18]. Additional functionalities of a sales configurator may include providing real-time information on price and/or delivery terms of a product variant, making quotations [19, 20] and recommending a product solution that can be further altered [13]. Sales configurators may be stand-alone applications or modules of other applications, known as product configurators, which support both sales specifications and the creation of product data necessary to build the product variant requested by the customer, such as bill of materials, production sequence, etc. [21].

Many studies on sales configurators and, more generally, on product configurators have investigated technical or application development issues, such as the modeling of configuration knowledge or the algorithms to make configurators faster and more accurate [e.g., 22, 23-28]. Many other studies have provided detailed accounts of the introduction and use of a configurator in a single company, focusing mainly on implementation challenges and operational performance outcomes from the company perspective [e.g., 19, 20, 29, 30-32]. In this vein, large-scale hypothesis-testing studies on the effects of product configurator use on a firm's operational performance have recently appeared as well [33, 34].

Instead, less attention has been given in literature to which characteristics of sales configurators reduce the effort involved in the specification process and drive users' satisfaction with this process [14], thereby alleviating the risk that companies experience the product variety paradox [12]. In particular, the empirical study of how sales configurators should be designed to ease the customer decision process and to increase configuration process-related value for the customer is still in its infancy [14, 35]. To help narrow this research gap, the present paper conceptualizes, develops and validates five sales configurator capabilities that are expected to motivate and facilitate further empirical investigation in the field.

2 BACKGROUND

Literature has suggested several mechanisms that can explain the product variety paradox [11]. In particular, four inter-related mechanisms link product variety and customization to the difficulty experienced by potential customers in configuring the product solutions that best fit their needs within a company's product space. Difficulty in the decision process may become a criterion for the potential customer's evaluation of the decision outcome itself [9, 11, 36, 37], leading to lower satisfaction with the

[1] Department of Management and Engineering, University of Padova, Padova, Italy, email: cipriano.forza@unipd.it

configured products and, eventually, reduced willingness to make a purchase [9, 11].

A first explanation for the product variety paradox relies on choice complexity, defined as the amount of information processing necessary to make a decision [9]. As product variety and customization increase, so too does choice complexity, since more alternatives have to be processed in order for a potential customer to make a decision based on rational optimization. The amount of information processing is a widely acknowledged source of decision difficulty [38]. If potential customers are provided with "too much" information at a given time, such that it exceeds their processing limits, information overload occurs [39]. Information overload, in turn, may lead potential customers to choose from competing brands that do not require such cognitive effort [5] thus reducing the company's revenues.

A related explanation for the product variety paradox relies on anticipation of post-decisional regret, which is a cognitively determined negative emotion that individuals experience when realizing or imagining that their present situation would have been better, had they acted differently [40]. When choice complexity becomes excessive, potential customers may become unable to invest the requisite time and effort in seeking the best option for them, thus basing their decision on heuristics which reduce information processing demands by ignoring potentially relevant information [38, 41, 42]. Furthermore, potential customers may have uncertain preferences because of poorly developed preferences or poor insight into their preferences [42-44]. When potential customers are unable to engage in rational optimization and/or have uncertain preferences, they may anticipate the possibility of post-decisional regret, due to poor fit between the selected product configuration and their preferences [7, 8, 45], and try to minimize this possibility during the decision process [8, 45]. This goal makes their decision processes more difficult [7] and may lead them to delay their purchase decisions [7, 45] or to prefer a standard product to a customized one [8].

A third related explanation for the product variety paradox relies on responsibility felt by potential customers for making a good decision. As product variety and customization increase, potential customers feel more responsible for their choices, given the greater opportunity of finding the very best option for them [7, 11]. These enhanced feelings of responsibility promote anticipated regret, as subjectively important decisions, for which individuals feel more responsible, will result in more intense post-decisional regret when things go awry [40, 45]. By amplifying anticipated regret and the resulting decision difficulty, responsibility for making a good decision magnifies the negative impact of choice complexity on customers' willingness to make a purchase.

Finally, a fourth mechanism relating product variety and customization to decision difficulty relies on conflict between product attributes that are highly valued by potential customers [5, 9, 38, 46]. To increase product variety and customization, companies need to broaden the range of product attributes on which they allow their potential customers to make a choice [47]. As the number of product-differentiation attributes increases, so too does the likelihood that potential customers have to face trade-offs among attractive attributes. This happens because offering all the possible combinations of all the different levels of the various product-differentiation attributes may be economically unfeasible, owing to insufficient manufacturing process flexibility and limited product modularity [48]. Explicit trade-offs among attractive attributes not only increase the cognitive effort required of potential customers to process all of the available information [5], but also cause potential customers to experience negative emotions such as anticipated regret [5]. This happens because trade-off resolution involves consideration of potential unwanted consequences and threatens one's reputation of self-esteem as a decision maker [49]. These negative emotions are another mechanism that increase subjective experience of choice task difficulty [9] and decreased satisfaction with the chosen product [11], thus explaining the product variety paradox.

3 CONSTRUCT DEVELOPMENT

In the following subsections, we propose five sales configurator capabilities that help companies avoid the product variety paradox by hindering operation of at least one of the mechanisms outlined in the previous section. These capabilities were identified based on a comprehensive literature review and the authors' experience in the design and implementation of product configurators.

3.1 Focused navigation capability

We define focused navigation capability as the ability to quickly focus a potential customer's search on a product space subset that contains the product configuration that best matches his/her idiosyncratic needs. A fundamental way of improving focused navigation capability is to allow potential customers to sequence their choices on product-differentiation attributes from the least uncertain choice to the most uncertain one [12]. This is because, in relation to the attribute being considered, a customer's preferences may be more or less uncertain [43] and preference uncertainty is an antecedent of anticipated regret [8, 50]. If the customer's early choices are those for which his/her preferences are best developed, then he/she is enabled to narrow down the search more quickly, as anticipated regret associated with those choices is lower. Noteworthy, a prerequisite for this way of structuring the customer-company interaction is the by-attribute presentation of the company's product space, meaning that the customer is asked which value he/she prefers for each product-differentiation attribute instead of being required to choose from among a set of fully-specified product configurations, as happens with the by-alternative presentation [6]. Another option to enhance focused navigation capability is to provide one or more starting points, that is, initial product configurations close to the customer's ideal solution and that may be further altered [13]. Starting points can be recommended with little or no effort on the customer's part, based on his/her past purchases and/or customer input concerning simple demographics, intended product usage and his/her best developed preferences [26, 51]. Noteworthy, this solution requires complementing the by-attribute presentation of the product space with the by-alternative presentation.

Focused navigation capability helps avoid the product variety paradox by reducing choice complexity and by mitigating anticipated regret. A sales configurator with this capability does not force potential customers to go through and evaluate a number of product options that they regard as certainly inappropriate for themselves. Therefore, this capability reduces the amount of information processing necessary to make a decision without potential customers experiencing anticipated regret [8, 40, 45, 50]. Furthermore, by quickly reducing the size of the search problem, this capability enables potential customers to invest more time and

effort in exploring the product options for which their preferences are less certain. Potential customers can learn more about both these options and the value they would derive from them, especially when focused navigation capability is complemented with the capabilities discussed in the subsequent sections. In addition, a potential customer can rely on more time-consuming, compensatory decision strategies for the resolution of between-attribute conflicts [42], thus being more confident that the chosen solution is the one that best fits his/her needs within the company's product space. Reduced uncertainty on the superior fit of the selected product configuration with the customer's preferences, in turn, translates into less anticipated regret [45].

3.2 Benefit-cost communication capability

We define benefit-cost communication capability as the ability to effectively communicate the consequences of the available choice options both in terms of what the customer gets (benefits) and in terms of what the customer gives (monetary and nonmonetary costs). A fundamental way of improving benefit-cost communication capability is to explain what potential needs a given choice option contributes to fulfill and to what extent it does so [12]. This is especially important when choice options involve design parameters of the product, such as specifications of product components, because potential customers are often unable to relate design parameters to satisfaction of user needs [13]. Besides the benefits, it is also important to communicate monetary and nonmonetary costs of each option, for example by displaying the prices of the individual product components from among which potential customers can choose or by warning potential customers that certain options imply longer delivery lead-times [12].

Benefit-cost communication capability helps avoid the product variety paradox by mitigating anticipated regret. During the sales configuration process, potential customers seek to anticipate the value they will perceive from consumption of the product being configured [54]. Perceived product value is defined as the customer's "overall assessment of the utility of a product based on perceptions of what is received and what is given" [55: 14]. By delivering clear pre-purchase feedback on the effects of the available choice options, a sales configurator with high benefit-cost communication capability fosters potential customers' learning about the value they would derive from these options [56, 57]. This learning process makes a potential customer more confident that the product configuration he/she has selected is the one that best fits his/her needs within the company's product space. Reduced uncertainty on the superior fit of the chosen product configuration with the customer's preferences, in turn, translates into less anticipated regret [45], thus lowering choice task difficulty [7].

At the same time, however, higher benefit-cost communication capability may lead to greater choice complexity, with negative effects on decision difficulty. For instance, individual pricing of the available choice options may make cost-benefit trade-offs more salient and, hence, may increase information processing demands [58]. To fully realize the potential advantages of benefit-cost communication capability, therefore, this capability needs to be complemented with the focused navigation one, which lowers choice complexity by quickly reducing the size of the search problem for potential customers. As a result, the learning process enabled by benefit-cost communication capability focuses only on those choice options for which potential customers' preferences are less certain and, thus, the possible negative effects of this capability on choice complexity are mitigated.

3.3 Flexible navigation capability

We define flexible navigation capability as the ability to minimize the effort required of a potential customer to modify a product configuration that he/she has previously created or is currently creating. A fundamental way of improving flexible navigation capability is to allow sales configurator users to change the choice made at any previous step of the configuration process without having to start it over again [13]. Furthermore, after changing the choice made at a given step, potential customers should not be required to go through all the subsequent steps up to the current one. Instead, they should be asked to revise only those choices, if any, that are no longer valid because of the change they have just made [59]. Another option to enhance flexible navigation capability is to allow potential customers engaged in configuring their products to bookmark their works [13],to immediately recover a previous configuration in the case that they decide to reject the newly-created one.

Flexible navigation capability helps avoid the product variety paradox by mitigating anticipated regret. A sales configurator with this capability enables potential customers to quickly make and undo changes to previously created product configurations. Consequently, the number of product solutions a potential customer can explore in the time span he/she is willing to devote to the sales configuration task is larger. Stated otherwise, potential customers can conduct more trial-and-error tests to evaluate the effects of initial choices made and to improve upon them. Trial-and-error experimentation promotes potential customers' learning about the value they would derive from the product being configured [56, 57], especially when flexible navigation capability is complemented with the benefit-cost communication one as well as those discussed in the subsequent sections. This learning process makes potential customers more confident that the product configuration they have selected is the one that best fits their needs within the company's product space. This, in turn, translates into less anticipated regret for the customer [45].

3.4 Easy comparison capability

We define easy comparison capability as the ability to minimize the effort required of a potential customer to compare previously created product configurations. A fundamental way of improving easy comparison capability is to allow potential customers to save a product configuration they have just created and, then, to compare previously saved configurations side-by-side in the same screen [13]. The advantages of providing an overview of previous configurations can be enhanced by highlighting commonalities and differences among them, especially if the sales configuration process involves many choices. In this manner, a potential customer can immediately understand, for example, which configuration choices have caused the price or weight difference between two configurations he/she is comparing. Another solution to enhance easy comparison capability is to rank-order previously created configurations in terms of fit to the customer's preferences or profile [43]. This can be accomplished with little or no effort on the customer's part, based on his/her past purchases and/or

customer input concerning simple demographics, intended product usage and his/her best developed preferences [26, 51].

Easy comparison capability helps avoid the product variety paradox by reducing choice complexity and by mitigating anticipated regret. A sales configurator with this capability fosters potential customers' learning about the value they would derive from consumption of the product being configured. This happens because, in assessing the value of a particular product solution, customers tend to rely on comparisons with other alternatives that are currently available or that have been encountered in the past [43, 60]. In particular, the possibility of easily comparing complete product configurations is of greatest assistance when global performance characteristics, which arise from the physical properties of most if not all of the product components [48], are important to potential customers. In brief, easy comparison capability gives potential customers practice at evaluating alternative configurations and provides anchors for the evaluative process [6]. Consequently, potential customers improve their confidence that the configuration they have eventually selected is the one that best fits their needs within the company's product space. In turn, reduced uncertainty on the superior fit of the chosen product configuration with the customer's preferences translates into less anticipated regret [45]. A sales configurator with high easy comparison capability also alleviates choice complexity, by reducing information processing necessary to make comparisons. Potential customers do not need to rely on their limited working memory to recover configurations they have previously created. Moreover, potential customers do not need to rely on their limited computational abilities to decompose the configurations they want to compare to find out similarities and differences among them.

3.5 User-friendly product-space description capability

We define user-friendly product-space description capability as the ability to adapt the product space description to the needs and abilities of different potential customers, as well as to different contexts of use. One way of improving user-friendly product-space description capability is to employ content adaptation techniques [cf. 61] to provide optional detailed information pertaining to the available choice options. In this manner, potential customers with higher involvement for the product, who are more interested in acquiring product information [62], are allowed to learn more about the choice options for which their preferences are less developed. Conversely, customers with lower involvement, who feel less responsible for making a good decision [45], are not forced to process product information they are not interested in. In this respect, a promising approach is to design multimedia-based interfaces that enable potential customers to retrieve rich information and explanations about specific product parts/features without breaking the continuity of their product evaluation processes [63]. Another option to enhance user-friendly product-space description capability is to adapt information content presented to potential customers according to their prior knowledge about the product [13, 52]. Particularly, novice customers should be allowed to use a needs-based interface, where the available choice options involve desired product performance and functions, while expert customers should be enabled to employ a parameter-based interface, where the available choice options include design parameters such as specifications of product components [12, 64].

User-friendly product-space description capability helps avoid the product variety paradox by reducing choice complexity and by mitigating anticipated regret. A sales configurator deploying this capability provides potential customers with the information content they value most according to their individual characteristics or usage contexts and does not bother users with communications they do not need [52]. In addition, a sales configurator with this capability augments or switches modalities of presentation of the same information content in such a way that each individual user's information processing is enhanced [67]. By tailoring both information content and information format, this capability reduces information overload and eases the customer decision process [68-70]. In particular, this capability allows for aligning the way in which the product space is presented to a potential customer with the way in which he/she is able or willing to express his/her requirements [56, 57]. As potential customers interact with a sales configurator in their customary language, they become able to assess the fit of the configured product with their needs more easily and in less time [71]. This means that, once a potential customer has selected his/her most preferred product configuration, he/she is more confident that the chosen solution is the one that best fits his/her needs within the company's product space. Reduced uncertainty on the superior fit of the selected product configuration with the customer's preferences, in turn, translates into less anticipated regret [45].

4 MEASURES DEVELOPMENT AND VALIDATION

We adopted a comprehensive, multi-step approach for the development, refinement and validation of the sales configurator capabilities measures. First, we generated a list of items based on both the relevant literature and subject matter experts' advice in order to ensure content validity of our instrument. Then, these items were reviewed by a focus group and through a field pretest, to reduce redundancy and ambiguity. Subsequently, we assessed and improved the reliability and the validity of the instrument by means of a Q-sort procedure. Finally, the resulting questionnaire (items are listed in Appendix A) was used to validate our measures, using large-scale data to assess the quality of the measures following the guidelines of O'Leary-Kelly and Vokurka [72].

4.1 Instrument development and refinement

The items for the five sales configurator capabilities were generated based upon the relevant literature, the authors' experience in industry, and extensive interviews with practitioners involved with the development and use of sales configurators. All the items were measured by means of a 7-point Likert scale. We used only positive statements, as negatively worded questions with an agree-disagree response format are often cognitively complex [73] and may be a source of method bias [74].

Then, the items were reviewed by a focus group of six people with different experiences and perceptions relative to sales configuration, who were questioned about the appropriateness and completeness of the instrument. Moreover, to replicate as closely as possible data collection procedures to be used in our large-scale study, we pretested the instrument with 20 engineering students from our university, who were asked to comment on any problems encountered while responding, such as interpretation difficulties,

faulty instructions, typos, item redundancies, etc. Based on the feedback from the focus group and field pretesting, redundant and ambiguous items were either modified or eliminated. Finally, the resulting instrument was evaluated through a Q-sort procedure for establishing tentative indications of construct validity and reliability [75]. Each of ten practitioners who are experienced in developing or using sales configurators was given a questionnaire containing short descriptions of the proposed capabilities, together with a randomized list of the items. Subsequently, these expert judges were asked to assign each item to one or none of the defined capabilities. All the items were placed in the target construct by at least 75% of the judges and, therefore, were retained for our large-scale study [54].

4.2 Sample and data collection

Each of the proposed sales configurator capabilities indicates a fundamental benefit that potential customers should experience during the sales configuration process if the product variety paradox is to be avoided. Consistent with the capability perspective of routines, which sees routines as a "black box" [76], we do not focus on how such benefits are delivered, but rather on their purpose or motivation. Accordingly, to measure the proposed sales configurator capabilities, we needed to collect data on sales configurations experiences made by potential customers using sales configurators. Specifically, data for our large-scale study were gathered on a sample of 630 sales configuration experiences made by 63 engineering students at the authors' university (age range: 24-27; 29% females) using Web-based sales configurators for consumer goods. As a result, our data are biased in favor of young, male, and fairly adept persons who are familiar with the Internet. At the same time, however, young people adept at using Internet also represent the majority of business-to-consumer sales configurator users [35, 78].

The Web-based sales configurators used in the study largely varied in the graphical solutions deployed, in the complexity and length of the configuration process, and also in the size of the configuration space. They ranged from shoes configurators, where the customer could personalize simple product attributes (such as the colors of various parts of the product) with virtually no constrains, to cars configurators, where the customer had to choose among a set of predefined options with complex compatibility rules among them. Such differences in the selected sales configurators increased the variance of the sales configurators capabilities observed in our sample.

Each participant was pre-assigned 10 of these Web-based sales configurators. We assigned these configurators ensuring variance in the sales configurators capabilities to which each participant was exposed. Further, we ensured variance in the involvement of each participant in the products he/she had to configure, avoiding the assignment of products not of interest to him/her at all. Participants were then asked to configure a product on all these websites, according to their individual needs, and to fill out a questionnaire to rate the capabilities of each configurator.

4.3 Instrument validation

We decided to control for possible effects of participants' characteristics before assessing the psychometric properties of our measurement scales. Consequently, consistent with prior studies [79], we regressed our 17 indicators on 63 dummies representing the participants in our study and used the standardized residuals from this linear, ordinary least square regression model as our data in all the subsequent analyses.

Confirmatory factor analysis (CFA) was employed to assess unidimensionality, convergent validity, discriminant validity, and reliability of our measurement scales. In particular, we used LISREL 8.80 to conduct the analysis, with maximum likelihood estimation of the parameters in the model (factor loadings of the measurement items on their respective latent constructs, measurement errors, variance and covariance of the latent constructs). We estimated an a priori measurement model where the empirical indicators were restricted to load on the latent factor they were intended to measure. This model showed good fit indices (RMSEA (90% CI)= 0.047 (0.040; 0.054), χ^2/df (df) = 2.39 (109), CFI=0.991, NFI=0.984), meaning that our hypothesized factor structure reproduced the sample data well. Inspection of the standardized factor loadings further indicated that each of them was in its anticipated direction (i.e., positive correspondences between latent constructs and their posited indicators), was greater than 0.50, and was statistically significant at $p<0.001$. Altogether, these results suggested unidimensionality and good convergent validity of our measurement scales [80-83]. Unidimensionality implies that a set of empirical indicators reflect one, as opposed to more than one, underlying latent factor. Convergent validity ensures that the multiple items used as indicators of a construct significantly converge, or covary. Discriminant validity, which measures the extent to which the individual items of a construct are unique and do not measure other constructs, was tested using [84]'s procedure. For each latent construct, the square root of the average variance extracted (AVE) exceeded the correlation with all the other latent variables, thereby suggesting that our measurement scales represent distinct latent variables [84]. Reliability of a measurement scale, in turn, is established when the variance captured by the underlying latent factor is significantly larger than that captured by the error components. This was assessed using both AVE and the Werts, Linn, and Joreskog (WLJ) composite reliability method [85]. All the WLJ composite reliabilty values were greater than 0.70 and all the AVE scores exceeded 0.50, indicating that a large amount of the variance is captured by each latent construct rather than due to measurement error [84, 86].

Finally, we examined the predictive validity of our constructs by determining whether they exhibit relationships with other constructs in accordance with theory [87]. Our proposed sales configurator capabilities are posited to help firms avoid the risk that offering more product variety and customization to increase sales, paradoxically results in a loss of sales. Accordingly, these capabilities are hypothesized to positively influence both choice satisfaction (measured as in [9]) and purchase intention (measured following [88]). The structural model testing the hypotheses that the proposed sales configurator capabilities positively influence both choice satisfaction and purchase intention, showed a good fit to the data: RMSEA (90% CI) = 0.0432 (0.0372; 0.0493), χ2/df (df) = 2.18 (169), CFI=0.993, NFI=0.987. All the path coefficients are positive and statistically significant, indicating that each of the five sales configurator capabilities has a significant positive effect on both choice satisfaction and purchase intention and thus establishing the predictive validity of our constructs.

5 CONCLUSION

Drawing upon prior research concerning sales configurators and the customer decision process, the present paper conceptualizes five capabilities that sales configurators should deploy in order to help avoid the product variety paradox: namely, focused navigation, flexible navigation, easy comparison, benefit-cost communication, and user-friendly product-space description capabilities. Overall, these capabilities support personalization of the sales configuration experience according to each individual user's characteristics and context of usage. Benefit-cost communication capability combined with user-friendly product-space description capability supports personalization on the content and presentation levels [cf. 89], while focused navigation, flexible navigation, and easy comparison capabilities support personalization on the interaction level [cf. 89]. Personalization of the sales configuration experience is essential to build successful sales configurators, which improve fit between selected product configuration and customer needs while limiting search effort [cf. 89, 90]. The ultimate goal would be to simulate the adaptive and heuristic behavior that makes salespeople effective and aids in improving both the shopping experience and the final product choice [91, 92].

Another contribution of this study is the development and validation of an instrument to measure the proposed set of capabilities. The instrument was rigorously tested for content validity, unidimensionality, convergent validity, discriminant validity, predictive validity, and reliability. In particular, we found that each of the proposed capabilities significantly predicts both choice satisfaction and purchase intention, in accord with the theoretical argument that these capabilities help avoid the product variety paradox. Admittedly, our large-scale validation study involved hypothetical rather than real purchase experiences, only focused on sales configurators for consumer goods, and used students as subjects for research. Therefore, future studies should strengthen the proposed instrument through a series of refinements and tests across different populations and settings, including truly representative samples of potential customers, sales configurators for industrial goods, etc. In business-to-business contexts, for instance, the set of relevant sales configurator capabilities for avoiding the product variety paradox should be reconsidered. For technical and complex products, such as machinery, it may happen that all configurator users are experts with deep knowledge of the specific product. In such a context, user-friendly product-space description capability might be less relevant.

Though conscious that development of a measurement instrument is an ongoing process [93], we believe our instrument will be a useful diagnostic and benchmarking tool for companies seeking to assess their sales configurators to identify areas of improvement in order to ease the customer decision process and to increase his/her process-related value. This would help companies reduce the risk of developing high product and processes internal competences but still experiencing a loss of sales because customers feel confused and overwhelmed by the number of product configurations they are offered.

Further, we believe the instrument developed in this paper will be of use to researchers not only as a basis for refinement and extension, but also directly. Future studies could develop and test hypotheses linking the proposed capabilities to the various dimensions of the value of customization that have been discussed in literature [35, 54, 78]. In particular, further research is needed to empirically investigate complementarities among the proposed capabilities, meaning that the effects of one capability on the customer perceived value of customization is reinforced by another capability, as our paper suggests.

ACKNOWLEDGEMENTS

We acknowledge the financial support of the University of Padova, Project ID CPDA109359.

APPENDIX A

Benefit-cost communication capability: (1) Thanks to this system, I understood how the various choice options influence the value that this product has for me. (2)Thanks to this system, I realized the advantages and drawbacks of each of the options I had to choose from. (3) This system made me exactly understand what value the product I was configuring had for me.

Easy comparison capability: (1) The system enables easy comparison of product configurations previously created by the user. (2) The system lets you easily understand what previously created configurations have in common. (3) The system enables side-by-side comparison of the details of previously saved configurations. (4) The systems lets you easily understand the differences between previously created configurations.

User-friendly product-space description capability: (1) The system gives an adequate presentation of the choice options for when you are in a hurry, as well as when you have enough time to go into the details. (2) The product features are adequately presented for the user who just wants to find out about them, as well as for the user who wants to go into specific details. (3) The choice options are adequately presented for both the expert and inexpert user of the product.

Flexible navigation capability: (1) The system enables you to change some of the choices you have previously made during the configuration process without having to start it over again. (2) With this system, it takes very little effort to modify the choices you have previously made during the configuration process. (3) Once you have completed the configuration process, this system enables you to quickly change any choice made during that process.

Focused navigation capability: (1) The system made me immediately understand which way to go to find what I needed. (2) The system enabled me to quickly eliminate from further consideration everything that was not interesting to me at all. (3) The system immediately led me to what was more interesting to me. (4) This system quickly leads the user to those solutions that best meet his/her requirements.

REFERENCES

[1] B.J.II Pine, *Mass Customization: the New Frontier in Business Competition*, Harvard Business School Press, Boston, MA, 1993.

[2] L.F. Scavarda, A.Reichhart, S.Hamacher, and M. Holweg, 'Managing product variety in emerging markets', *International Journal of Operations & Production Management*, **30**, 205-224, (2010).

[3] M. Bils and P.J. Klenow, ‘'The acceleration in variety growth', *The American Economic Review*, **91**, 274-280, (2001).

[4] S. Kekre and K. Srinivasan, 'Broader product line: a necessity to achieve success?', *Management Science*, **36**, 1216-1231, (1990).

[5] J.T. Gourville and D. Soman, 'Overchoice and assortment type: when and why variety backfires', *Marketing Science*, **24**, 382-395, (2005).

[6] C. Huffman and B.E. Kahn, 'Variety for sale: mass customization or mass confusion?', *Journal of Retailing*, **74**, 491-513, (1998).

[7] S.S. Iyengar and M.R. Lepper, 'When choice is demotivating: can one desire too much of a good thing?', *Journal of Personality and Social Psychology*, **79**, 995-1006, (2000).

[8] N. Syam, P. Krishnamurthy, and J.D. Hess, 'That's what i thought i wanted? Miswanting and regret for a standard good in a mass-customized world', *Marketing Science*, **27**, 379-397, (2008).

[9] A. Valenzuela, R. Dhar, and F. Zettelmeyer, 'Contingent response to self-customization procedures: implications for decision satisfaction and choice', *Journal of Marketing Research*, **46**, 754-763, (2009).

[10] X. Wan, P.T. Evers, and M.E. Dresner, 'Too much of a good thing: the impact of product variety on operations and sales performance', *Journal of Operations Management*, **30**, 316-324, (2012).

[11] K. Diehl and C. Poynor, 'Great expectations?! Assortment size, expectations, and satisfaction', *Journal of Marketing Research*, **47**, 312-322, (2010).

[12] F. Salvador and C. Forza, 'Principles for efficient and effective sales configuration design', *International Journal of Mass Customisation*, **2**, 114-127, (2007).

[13] T. Randall, C. Terwiesch, and K.T. Ulrich, 'Principles for user design of customized products', *California Management Review*, 47, 68-85, (2005).

[14] M. Heiskala, J. Tiihonen, K.-S. Paloheimo, and T. Soininen, *Mass customization with configurable products and configurators: a review of benefits and challenges*, 1-32, in: Mass Customization Information Systems in Business, T. Blecker, G. Friedrich (Eds.), IGI Global, London, UK, 2007.

[15] C. Forza and F. Salvador, 'Application support to product variety management', *International Journal of Production Research*, **46**, 817-836, (2008).

[16] A. Haug, L. Hvam, and N.H. Mortensen, 'Definition and evaluation of product configurator development strategies', *Computers in Industry*, (in press).

[17] M.M. Tseng and T.F. Piller, *The Customer Centric Enterprise: Advances in Mass Customization and Personalization*, Springer Verlag, Berlin, Germany, 2003.

[18] N. Franke and F.T. Piller, 'Key research issues in user interaction with user toolkits in a mass customization system', *International Journal of Technology Management*, **26**, 578-599, (2003).

[19] J. Vanwelkenhuysen, 'The tender support system', *Knowledge-based systems*, **11**, 363-372, (1998).

[20] L. Hvam, S. Pape, and M.K. Nielsen, 'Improving the quotation process with product configuration', *Computers in Industry*, **57**, 607-621, (2006).

[21] C. Forza and F. Salvador, *Product Information Management for Mass Customization*, Palgrave Macmillan, London, UK, 2007.

[22] S.M. Fohn, J.S. Liau, A.R. Greef, R.E. Young, and P.J. O'Grady, 'Configuring computer systems through constraint-based modeling and interactive constraint satisfaction', *Computers in Industry*, **27**, 3-21, (1995).

[23] T. Soininen, J. Tiihonen, T. Männistö, R. Sulonen 'Towards a general ontology of configuration', *Artificial Intelligence for Engineering, Design, Analysis and Manufacturing*, **12**, 357-372, (1998).

[24] A. Felfernig, G. Friedrich, and D. Jannach, 'Conceptual modeling for configuration of mass-customizable products', *Artificial Intelligence in Engineering*, **15**, 165-176, (2001).

[25] S.K. Ong, Q. Lin, and A.Y.C. Nee, 'Web-based configuration design system for product customization', *International Journal of Production Research*, 44, 351-382, (2006).

[26] X. Luo, Y. Tu, J. Tang, and C.K. Kwong, 'Optimizing customer's selection for configurable product in B2C e-commerce application', *Computers in Industry*, **59**, 767-776, (2008).

[27] P.T. Helo, Q.L. Xu, S.J. Kyllönen, and R.J. Jiao, 'Integrated vehicle configuration system-Connecting the domains of mass customization', *Computers in Industry*, **61**, 44-52, (2010).

[28] G. Hong, D. Xue, and Y. Tu, 'Rapid identification of the optimal product configuration and its parameters based on customer-centric modeling for one-of-a-kind production', *Computers in Industry*, **61**, 270-279, (2010).

[29] J.R. Wright, E.S. Weixelbaum, G.T. Vesonder, K.E. Brown, S.R. Palmer, J.I. Berman, and H.H. Moore, 'A knowledge-based configurator that supports sales, engineering, and manufacturing at AT&T network systems', *AI Magazine*, **14**, 69-80, (1993).

[30] L. Hvam, 'Mass customisation in the electronics industry: based on modular products and product configuration', *International Journal of Mass Customisation*, **1**, 410-426, (2006).

[31] C. Forza and F. Salvador, 'Managing for variety in the order acquisition and fulfilment process: the contribution of product configuration systems', *International Journal of Production Economics*, **76**, 87-98, (2002).

[32] C. Forza and F. Salvador, 'Product configuration and inter-firm co-ordination: an innovative solution from a small manufacturing enterprise', *Computers in Industry*, **49**, 37-46, (2002).

[33] A. Trentin, E. Perin, and C. Forza, 'Overcoming the customization-responsiveness squeeze by using product configurators: beyond anecdotal evidence', *Computers in Industry*, **62**, 260-268, (2011).

[34] A. Trentin, E. Perin, C. Forza, "Organisation design strategies for mass customisation: an information-processing-view perspective", *International Journal of Production Research*, forthcoming.

[35] N. Franke and M. Schreier, 'Why customers value mass-customized products: the importance of process effort and enjoyment', *Journal of Product Innovation Management*, **27**, 1020-1031, (2010).

[36] G.J. Fitzsimons, 'Consumer response to stockouts', *Journal of Consumer Research*, **27**, 249-266, (2000).

[37] N. Novemsky, R. Dhar, N. Schwarz, I. Simonson, 'Preference fluency in choice', *Journal of Marketing Research*, **44**, 347-356, (2007).

[38] S. Chatterjee and T.B. Haeth, 'Conflict and loss aversion in multiattribute choice: the effects of trade-off size and reference dependence on decision difficulty', *Organizational Behavior and Human Decision Processes*, **67**, 144-155, (1996).

[39] N.K. Malhotra, 'Information load and consumer decision making', *Journal of Consumer Research*, **8**, 419-430, (1982).

[40] M. Zeelemberg, W.W. van Dijk, and A.S.R. Manstead, 'Reconsidering the relation between regret and responsibility', *Organizational Behavior and Human Decision Processes*, **74**, 254-272, (1998).

[41] J.W. Payne, J.R. Bettman, and E.J. Johnson, 'Adaptive strategy selection in decision making', *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **14**, 534-552, (1988).

[42] J.R. Bettman, M.F. Luce, and J.W. Payne, 'Constructive consumer choice processes', *Journal of Consumer Research*, **25**, 187-217, (1998).

[43] I. Simonson, 'Determinants of customers' responses to customized offers: conceptual framework and research propositions', *Journal of Marketing*, **69**, 32-45, (2005).

[44] I. Simonson, 'Regarding inherent preferences', *Journal of Consumer Psychology*, **18**, 191-196, (2008).

[45] M. Zeelemberg, 'Anticipated regret, expected feedback and behavioral decision making', *Journal of Behavioral Decision Making*, **12**, 93-106, (1999).

[46] R. Dhar, 'Consumer preference for a no-choice option', *Journal of Consumer Research*, **24**, 215-231, (1997).

[47] F. Salvador, C. Forza, and M. Rungtusanatham, 'Modularity, product variety, production volume, and component sourcing: theorizing beyond generic prescriptions', *Journal of Operations Management*, **20**, 549-575, (2002).

[48] K. Ulrich, 'The role of product architecture in the manufacturing firm', *Research Policy*, **24**, 419-440, (1995).

[49] M.F. Luce, 'Choosing to avoid: coping with negatively emotion-laden consumer decisions', *Journal of Consumer Research*, **24**, 409-433, (1998).

[50] J. Nasiry and I. Popescu, 'Advance selling when consumers regret', *Management Science*, (in press).

[51] A. De Bruyn, J.C. Liechty, E.K.R.E. Huizingh, and G.L. Lilien, 'Offering onlinerecommendations with minimum customer input through conjoint-based decision aids', *Marketing Science*, **27**, 443-460, (2008).

[52] S. Spiekermann and C. Parashiv, 'Motivating human-agent interaction: transferring insights from behavioral marketing to interface design', *Electronic Commerce Research*, **2**, 255-285, (2002).

[53] A.G. Sutcliffe, S. Kurniawan, and J.-E. Shin, 'A method and advisor tool for multimedia user interface design', *International Journal of Human-Computer Studies*, **64**, 375-392, (2006).

[54] A. Merle, J.-L. Chandon, E. Roux, and F. Alizon, 'Perceived value of the mass-customized product and mass customization experience for individual consumers', *Production and Operations Management*, **19**, 503-514, (2010).

[55] V. Zeithaml, 'Consumer perceptions of price, quality, and value: a means-end model and synthesis of evidence', *Journal of Marketing*, **52**, 2-22, (1988).

[56] E. von Hippel, 'PERSPECTIVE: User toolkits for innovation', *Journal of Product Innovation Management*, **18**, 247-257, (2001).

[57] E. von Hippel and R. Katz, 'Shifting innovation to users via toolkits', *Management Science*, **48**, 821-833, (2002).

[58] B.G.C. Dellaert and S. Stremersch, 'Marketing mass-customized products: striking a balance between utility and complexity', *Journal of Marketing Research*, **42**, 219-227, (2005).

[59] B. Yu and J. Skovgaard, 'A configuration tool to increase product competitiveness', *IEEE Intelligent Systems*, **13**, 34-41, (1998).

[60] I. Simonson and A. Tversky, 'Choice in contexts: tradeoff contrasts and extremeness aversion', *Journal of Marketing Research*, **29**, 281-295, (1992).

[61] A. Kobsa, J. Koenemann, and W. Pohl, 'Personalised hypermedia presentation techniques for improving online customer relationships', *The Knowledge Engineering Review*, **16**, 111-155, (2001).

[62] J.L. Zaichkowsky, 'Measuring the involvement construct', *Journal of Consumer Research*, **12**, 341-352, (1985).

[63] Z. Jiang, W. Wang, and I. Benbasat, 'Multimedia-based interactive advising technology for online consumer decision support', *Communications of the ACM*, **48**, 93-98, (2005).

[64] T. Randall, C. Terwiesch, and K.T. Ulrich, 'Principles for user design of customized products', *California Management Review*, 47, 68-85, (2005).

[65] J.H. Gerlach and F.-Y. Kuo, 'Understanding human-computer interaction for information systems design', *MIS Quarterly*, **15**, 527-549, (1991).

[66] L.M. Reeves, J.Lai, J.A.Larson, S.Oviatt, T.S. Balaji, S. Buisine, P. Collings, P. Cohen, B. Kraal, J.-C. Martin, M. McTear, T. Raman, K.M. Stanney, H. Su, and Q.-Y. Wang, 'Guidelines for multimodal user interface design', *Communications of the ACM*, **47**, 57-59, (2004).

[67] K. Stanney, S. Samman, L. Reeves, K. Hale, W. Buff, C. Bowers, B. Goldiez, D. Nicholson, and S. Lackey, 'A paradigm shift in interactive computing: deriving multimodal design principles from behavioral and neurological foundations', *International Journal of Human-Computer Interaction*, **17**, 229-257, (2004).

[68] A. Ansari and C.F. Mela, 'E-customization', *Journal of Marketing Research*, **40**, 131-145, (2003).

[69] T.-P. Liang, H.-J. Lai, and Y.-C. Ku, 'Personalized content recommendation and user satisfaction: theoretical synthesis and empirical findings', *Journal of Management Information Systems*, **23**, 45-70, (2006-7).

[70] H. Berghel, 'Cyberspace 2000: Dealing with information overload', *Communications of the ACM*, **40**, 19–24, (1997).

[71] T. Randall, C. Terwiesch, and K.T. Ulrich, 'User design of customized products', *Marketing Science*, **26**, 268-280, (2007).

[72] S. W. O'Leary-Kelly, J. R. Vokurka, "The empirical assessment of construct validity", *Journal of Operations Management*, **16**, 387-405, (1998).

[73] F.J. Fowler, *Survey Research Methods*, Sage Publications, Newbury Park, CA, 1993.

[74] H.W. Marsh, 'Positive and negative global self-esteem: a substantively meaningful distinction or artifactors?' *Journal of Personality and Social Psychology*, **70**, 810-819, (1996).

[75] J.K. Stratman and A.V. Roth, 'Enterprise Resource Planning (ERP) competence constructs: two-stage multi-item scale development and validation', *Decision Sciences*, **33**, 601-628, (2002).

[76] A. Parmigiani and J. Howard-Grenville, 'Routines revisited: exploring the capabilities and practice perspectives', *The Academy of Management Annals*, **5**, 413-453, (2011).

[77] L. D'Adderio, 'Configuring software, reconfiguring memories: the influence of integrated systems on the reproduction of knowledge and routines', *Industrial and Corporate Change*, **12**, 321-350, (2003).

[78] N. Franke and M. Schreier, 'Product uniqueness as a driver of customer utility in mass customization', *Marketing Letters*, **19**, 93-107, (2008).

[79] G.J. Liu, R. Shah, and R.G. Schroeder, 'Linking work design to mass customization: a sociotechnical systems perspective', Decision Sciences, **37**, 519-545, (2006).

[80] D.W. Gerbing and J.C. Anderson, 'An updated paradigm for scale development incorporating unidimensionality and its assessment', *Journal of Marketing Research*, **25**, 186-192, (1988).

[81] J.C. Anderson and D.W. Gerbing, 'Structural equation modeling in practice: a review and recommended two-step approach', *Psychological Bulletin*, **103**, 411-423, (1988).

[82] L. Menor and A.V. Roth, 'New service development competence in retail banking: Construct development and measurement validation', *Journal of Operations Management*, **25**, 825–846, (2007).

[83] J.F.J. Hair, R.E. Anderson, and R.L. Tatham, *Multivariate Data Analysis*, Macmillan Publishing Company, New York, 1992.

[84] C. Fornell and D.F. Larcker, 'Evaluating structural equation models with unobservable variables and measurement error', *Journal of Marketing Research*, **18**, 39-50, (1981).

[85] C.E. Werts, R.L. Linn, and K.G. Jöreskog, 'Intraclass reliability estimates: testing structural assumptions', *Educational & Psychological Measurement*, **34**, 25-33, (1974).

[86] S.W. O'Leary-Kelly and R. J. Vokurka, 'The empirical assessment of construct validity', *Journal of Operations Management*, **16**, 387-405, (1998).

[87] S. Li, S.S. Rao, T.S. Ragu-Nathan, and B. Ragu-Nathan, 'Development and validation of a measurement instrument for studying supply chain management practices', *Journal of Operations Management*, **23**, 618-641, (2005).

[88] A.E. Schlosser, T.B. White, and S.M. Lloyd, 'Converting Web site visitors into buyers: how Web site investment increases consumer trusting beliefs and online purchase intentions', *Journal of Marketing*, **70**, 133-148, (2006).

[89] G. Kreutler and D. Jannach, *Personalized needs acquisition in Web-based configuration systems*, 293-302, in: Mass Customization, Concepts - Tools - Realization, Proceedings of the International Mass Customization Meeting 2005 (IMCM'05), T. Blecker, G. Friedrich (Eds.), GITO-Verlag, Berlin, Germany, 2005.

[90] D. Jannach, A. Felfernig, G. Kreutler, M. Zanker, and G. Friedrich, *Research issues in knowledge-based configuration*, 221-236, in: Mass customization information systems in business, T. Blecker, G. Friedrich (Eds.), IGI Global, London, UK, 2007.

[91] D. Jannach and G. Kreutler, 'Rapid development of knowledge-based conversational recommender applications with advisor suite', *Journal of Web Engineering*, 6, 165-192, (2007).

[92] A.V. Lukas, G. Lukas, D.L. Klencke, and C. Nass, System and method for optimizing a product configuration, Patent Number US 7,505,921 B1, Finali Corporation, Westminster, CO (US), US, 2009.

[93] R.L. Hensley, 'A review of operations management studies using scale development techniques', *Journal of Operations Management*, 17, 343-358, (1999).