# Strategic Capabilities of Mass Customization Based E-Commerce: Construct Development & Empirical Test

| Frank Piller | Thorsten Harzer | Christoph Ihl | Fabrizio Salvador |
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| RWTH Aachen University | Boston Consulting Group | RWTH Aachen University | IE Business School |
| piller@tim.rwth-aachen.de | harzer.thorsten@bcg.com | ihl@tim.rwth-aachen.de | fabrizio.salvador@ie.edu |

## Abstract

*Mass customization (MC), i.e. offering customers exactly what they want without losing in operational efficiency, has been positioned as a viable business strategy in ecommerce for many years. Still, many companies have failed in implementing profitable MC. We explain these failures by the lack of strategic capabilities in these firms and examine their effect on firm performance, drawing on a survey of 115 firms offering customized consumer goods on the internet. We build on complementarity theory and examine how multiple core elements of a MC strategy enhance company performance. We find that successful MC is based on the integration of various different organizational elements. Methodologically, we develop a set of valid and reliable instruments to measure three sub-dimensions of MC capability. We give advice to managers how firms pursuing MC can build all three capabilities complementarily to attain strategic differentiation and competitive advantage.*

## 1. Introduction

Undoubtedly heterogeneity of customer demand is increasing, and personalization is becoming an important driver of innovative business models, especially in ecommerce (Gownder 2011). But profiting from these developments seems to be far from easy. Numerous prominent companies were unable to create significant revenue streams from MC—think of failed ventures such as Reflect.com from Procter&Gamble, Original Spin Jeans from Levi's, or the miAdidas custom sport shoe initiative. At the same time, however, a large number of innovative startups have been successfully operating in exactly the same categories. Earlier research has found that MC demands more than just "fine tuning" a company's operations or installing a configuration toolkit (Brown and Bessant 2003); it involves developing multidimensional strategic capabilities in an evolutionary process (van Hoek et al. 1999).

However, previous research has provided little insight which strategic capabilities firms need to realize MC. To address this research gap, Salvador et al. (2009) proposed a conceptual framework of three capabilities of a successful MC firm. In this study, we aim to test this framework empirically and to examine its effect on firm performance, drawing on a sample of 115 MC firms operating in BtoC ecommerce. With this, we especially want to contribute to the scare empirical base of MC research on an aggregated level (Tu et al. 2004; Kumar et al. 2007; Moser 2007; Huang et al. 2010). The few existing empirical studies on MC can be divided into two groups: (1) surveys and experiments with end customers, addressing questions such as how customers handle choice complexity (Dellaert and Dabholkar 2009; Franke et al. 2010; Merle et al. 2010); and (2) large-scale empirical studies that approach MC from a company perspective, analyzing primarily the effectiveness of various practices (e.g., modularity, flexible manufacturing, quality management) in enhancing MC (Tu et al. 2004; Squire et al. 2006; Kristal et al. 2010).

However, the latter group of studies tested their hypotheses mostly using survey data collected from a convenience sample of medium to large mass manufacturers that merely apply some MC practices. These respondents can rarely be considered full mass customizers, and the findings therefore have limited generalizability for innovative startups and SMEs, especially in ecommerce, which built their business models from the ground up and are fully focused on MC. Here, our study wants to capture this recent wave of MC startups, almost exclusively operating on the internet only (Gownder 2011) by enforcing strict criteria in terms of the selection of respondents. To the best of our knowledge, our study represents the first large-scale empirical investigations of a relevant sample of pure-play mass customizers in BtoC ecommerce to determine how organizational elements may or may not enhance an organization's performance. We find that the capabilities do not improve corporate performance on their own. But we discover superadditive synergies arising from the simultaneous implementation of the strategic capabilities. Thus, our study contributes to the literature on establishing MC as an ecommerce strategy, while also providing important managerial advice for managers and entrepreneurs setting up a MC operation.

## 2. Strategic MC Capabilities

Broekhuizen and Alsem (2002) emphasize that it is primarily organizational capabilities that determine the capacity of a company to mass customize, including manufacturing flexibility, distribution and logistics flexibility, and customer information dissemination. But success in pursuing MC may also require the transformation of organizational structures, value systems, methods for knowledge creation and ways of relating to customers (Kotha 1996). In their empirical investigation of the link between capabilities and company performance, Tu et al. (2001) postulate that firms with MC capabilities should be able to generate greater profits. While this literature demonstrates agreement that MC firms must create distinctive capabilities, there is only little research on the exact composition of these capabilities. To our knowledge, the only comprehensive framework has been proposed by Salvador et al. (2009) who not only focus on manufacturing activities, but explicitly cover the entire value chain of MC from product development to customer interaction and sales. While this framework has been received well by the literature (it is among the most cited papers in *Google Scholar* published on MC in the last decade), Salvador et al.'s framework is based on anecdotal evidence only. Hence, our motivation is to provide an empirical test of this model for the first time. In their framework, Salvador et al. (2009) propose that successful MC organizations master three capabilities:

*Solution Space Development (SSD)*: Traditional manufacturers aim to identify the average preferences of customers in a specific segment and target them with a few standard products. In contrast, companies seeking to adopt MC must identify the idiosyncratic needs of individual customers and establish the product attributes on which customer needs diverge the most (Kumar et al. 2007). Based on this information, firms can define their solution space, clearly delineating what universe of benefits an offer intends to provide to customers, and what specific permutations of functionality can be provided within this universe (Franke et al. 2010; Merle et al. 2010). Consider the example of *NikeID*, an ecommerce offering of custom sneakers. SSD demands for Nike to determine which options of the shoe should be customized, shall it, e.g. focus on aesthetic attributes only (as it does today) or also include fit and performance attributes (like cushioning, materials), as it is done by its main competitor, Adidas. Concluding, SSD is the ability to identify idiosyncratic and unexploited needs and preferences of each customer, to optimize the functional, aesthetic, and hedonic fit between the product variants offered by a firm and the needs and preferences of every customer.

*Robust Process Design (RPD):* MC originally has conceptualized the possibilities of advanced, flexible manufacturing systems (Pine 1993). But robust processes are more: A MC fulfillment strategy must ensure that increased variability in customers' demand does not incur significant lead time or cost penalties along the entire supply chain (Åhlström and Westbrook 1999). MC companies implement stable but still flexible processes to achieve "mass production efficiency" in their operations and supply chains (Tseng and Jiao 2001). Consider the example of *Zazzle*, an established MC startup from the US that enables the personalization of dozens of items from t-shirts via cups and skateboards towards postal stamps with user-designed graphics or pictures. The firm has built a fulfillment system that efficiently handles more than 200,000 new product designs *per day*, shipping thousands of items to its global customer base. RPD for Zazzle not only includes its manufacturing system, but also managing configuration, order handling, shipping, and customer service in a highly efficient and automated way, despite the fact that not one order is the same. Concluding, RPD is the ability of an organization to reuse and/or recombine its resources along the value chain to address variability in customers' requirements, while avoiding any deterioration in the performance of the organization's processes compared with a mass production system.

*Choice Navigation (CN):* Finally, a MC manufacturer must develop a mechanism for obtaining specific information on customers' needs and preferences and then translating them into a definite product specification (Piller et al. 2004). This mechanism goes beyond a simple exchange of information between manufacturer and customer. Instead of passively choosing from a standard product assortment, consumers assume an active role and determine which product gets offered to them by specifying its attributes. Empirical evidence indicates that enjoyment of the co-design process has an added impact on the perceived value of the customized product and enhances willingness to pay (Franke and Schreier 2010; Merle et al. 2010). But co-design activities may also induce perceptions of greater complexity, effort, and risk among customers (Dellaert and Dabholkar 2009). In consequence customers might postpone their buying decisions, opt for a standard product alternative, or reassign their budget to a different vendor. Consider the example of *YouBars*, an online vendor of customized nutrition bars. Given the difficulties of illustrating "taste" in an online purchase, the firm had to provide sophisticated measures to simulate different configurations of ingredients. Even more, a nutrition bar is a functional product. Hence the firm has to provide a toolkit that captures the expected benefit and usage intention of the bar, and translates this information together with profiling information about each customer into an individual recipe for each customer's product. The corresponding CN capability thus is the ability of an organi-

zation to support customers in identifying their needs and creating their own solutions, such that choice complexity is minimized and enjoyment of the configuration process is maximized.

## 3. Hypothesis Development

Though anecdotal and case study evidence exists (e.g., Kotha 1995; Moser 2007; Salvador et al. 2009), no large-sample studies have demonstrate how these strategic elements enhance a MC firm's performance, and how they are related with each other. We propose that MC firms can gain a sustainable competitive advantage by developing and enhancing the three strategic capabilities. In our empirical study we attempt to empirically verify this proposition.

### 3.1 Single Effects on Company Performance

With regard to performance outcomes we consider customer satisfaction and superior sales growth (Slater and Narver 2000). Firms that deliver superior customer value likely enjoy high levels of customer satisfaction, which can be defined as the extent to which a product's perceived performance fulfills a buyer's expectations. This measure is widely accepted as a valid predictor of behavioral variables, such as repurchase intentions, positive word of mouth, and loyalty (Bolton et al. 2006) and also has been used in previous studies on MC (e.g., Wind and Rangaswamy 2001). However, the most accurate measure of customer value creation is probably sales growth relative to key competitors (Slater and Narver 2000). We thus propose the following capabilities–performance relationship: Enhancing any of the strategic capabilities for MC, ceteris paribus, contributes to the creation of superior customer value, which in turn leads to higher levels of customer satisfaction and faster sales growth relative to key competitors, potentially resulting in increased market share and profitability:

*H1: Solution space development capability has a positive direct effect on company performance.*
*H2: Robust process design capability has a positive direct effect on company performance.*
*H3: Choice navigation capability has a positive direct effect on company performance.*

### 3.2 Complementarity of Strategic Capabilities

Strategy literature suggests that beyond their distinct functions in firms, the three MC capabilities are interdependent and mutually supportive (Milgrom and Roberts 1995; Song et al. 2005). In order to implement a profitable and sustainable MC strategy, a business must integrate the different methods, tools, and routines that constitute these capabilities in practice. This reasoning is consistent with the concept of strategic fit (Porter 1996), which suggests that strategy is essentially about combining activities. The fit among activities substantially reduces costs and increases differentiation from the competition. However, resource constraints and powerful structural inertia might prevent companies embarking on MC from improving all three strategic capabilities simultaneously (Rungtusanatham and Salvador 2008), hence creating strategic performance effects among the population of MC firms. To illustrate this point consider a firm that has invested in latest configurator technology, hence implementing a CN system that effectively guides customers in designing a product that perfectly matches their needs. But if fulfilling these differentiated needs leads to a significant deterioration in the firm's operations, resulting in poor quality, long delivery times, and high price premiums, this will have a negative impact on repurchase intentions and customer loyalty. Hence, integrating SSD, RPD, and CN capabilities should lead to better company performance, being a complementary rather than a supplementary combination (Wernerfelt 1984). Complementary capabilities create super-additive value synergies that are not captured by any single capability in isolation (Milgrom and Roberts 1995). Conversely, the absence or weakness of one capability can diminish the value of the others as well. Moreover, bundles of complementary capabilities are also more difficult to observe and hence to imitate (Song et al. 2005). Due to the complementarity, implementing a single capability without developing the others will fail to deliver the intended performance improvements; it may even produce negative performance effects (Milgrom and Roberts 1995).

Whittington et al. (1999: 585) state that complementarity analyses require "a simultaneously aggregated and disaggregated approach that compares the contribution of individual practices with the performance payoffs of them altogether." Therefore, to assess the performance effects of complementary strategic capabilities, it is imperative to compare the effects of individual capabilities with the performance effect of the full system to define the conditionality of individual capabilities on one another and to ensure that overall effect outweighs the individual effects (Ichniowski et al. 1997). Accordingly, we propose:

*H4: Complementarity of solution space development, robust process design, and choice navigation has a positive effect on company performance.*
*H5: MC is a multidimensional, higher order construct comprised of solution space development, robust process design, and choice navigation.*

## 4. Methods

### 4.1 Sample and Data Collection

Our unit of analysis is MC firms operating in BtoC ecommerce, i.e. firms that provide an online toolkit for

customer co-design and market their products via the internet. Also, customization of the products must take place within the manufacturing processes by changing the physical characteristics of the products. Using the MC firm repositories configurator-database.com and egoo.de, and a dedicated web search, we identified 620 MC firms meeting these criteria. We believe that this sample can be regarded as a near exhaustive sample, as these firms represent virtually the entire MC universe in our target group in Europe and North America. From those, 118 MC firms responded, although we eliminated three responses due to excessive missing data, such that the overall response rate was 18.5% (115/620). A test for non-response bias (Armstrong and Overton 1977) shows any significant difference.

Descriptive statistics for the responding firms are provided in Table 1, which confirms the suitability of the sample for our research: 82.6% of the firms were founded exclusively with the purpose of MC. The majority of firms (56.5%) have operated their MC business between one and five years. This confirms earlier observations that the current dynamism in online MC is driven primarily by innovative startups that have built their business models from the ground up and focus entirely on the promises of MC. According to Forrester Research, Germany is a clear intellectual and practical leader in MC due to its long tradition in innovative manufacturing (Gownder 2011). This fact is well represented in our sample, with 59.1% of the respondents coming from Germany. The majority of respondents were from top management (87.0%). We are therefore confident that the respondents possess accurate knowledge with regard to the MC capabilities of their firm and the resulting performance effects.

### 4.2. Measures

Whenever possible, we used existing measurement instruments for the core constructs (see Appendix 1 for the measurement instrument). The scale used to measure RPD was adapted from Zhang et al. (2003). Full established scales for SSD and CN were not available. We therefore generated them specifically for this study based on a rigorous process that focused on attaining content validity by reviewing relevant literature and consulting with company executives. To further enhance the content validity, 15 attendees of an EMBA program on MC participated in a Q-sort exercise (Rungtusanatham 1998). We applied Fleiss' kappa (Fleiss 1971) to measure inter-rater correlations, and found with a resulting kappa value of 0.63 a "substantial agreement" (Landis and

Koch 1977) of the raters in assigning the items to the three capabilities.

Business performance is a crucial indicator when comparing strategic configurations of firms. During a pretest, however, firms were rather reluctant to disclose their absolute sales and performance figures. We hence relied on the market performance scale proposed by Homburg and Pflesser (2000) to obtain a relative measure of performance while preserving the respondents' privacy. As described during hypothesis development, firm performance is expressed by two constructs, sales growth (4 items) and customer satisfaction (3 items) (Slater and Narver 2000). All performance scales were five-point Likert-type with anchor points 1 = "much worse relative to main competitors," to 5 = "much better relative to main competitors." We did not include any item relating to profitability (e.g., return on sales). Such a measure would not be meaningful because many of our respondents are startups still experiencing the usual start-up losses. We followed standard procedure to establish construct validity, considering unidimensionality (convergent validity), reliability, and discriminant validity (e.g., Gerbing and Anderson 1988; Ahire et al. 1996). The descriptive statistics and correlations demonstrated generally good values for all items.

| Metric | Frequency | Percentage | Cumulative percentage |
|---|---|---|---|
| **Company type** | | | |
| Company founded with the purpose of MC | 95 | 82.6% | 82.6% |
| MC business unit of an established company with standard product range | 20 | 17.4% | 100.0% |
| **MC offering online** | | | |
| < 1 year | 32 | 27.8% | 27.8% |
| 1 to 5 years | 65 | 56.5% | 84.3% |
| > 5 years | 18 | 15.7% | 100.0% |
| **Sales in fiscal year 2010 (in USD)** | | | |
| < 100.000 | 57 | 49.6% | 49.6% |
| < 500.000 | 23 | 20.0% | 69.6% |
| < 1 million | 16 | 13.9% | 83.5% |
| < 5 million | 10 | 8.7% | 92.2% |
| > 5 million | 9 | 7.8% | 100.0% |
| **Number of employees (FTEs)** | | | |
| < 5 | 62 | 53.9% | 53.9% |
| 5 to 24 | 38 | 33.1% | 87.0% |
| 25 to 100 | 10 | 8.7% | 95.1% |
| > 100 | 5 | 4.3% | 100.0% |
| **Product categories** | | | |
| Food and beverage | 27 | 23.5% | 23.5% |
| Accessories and shoes | 21 | 18.3% | 41.8% |
| Apparel | 17 | 14.8% | 56.6% |
| Home decor and furniture | 13 | 11.3% | 67.9% |
| Sportswear and equipment | 7 | 6.1% | 74.0% |
| Toys | 5 | 4.3% | 78.3% |
| Photo printing | 5 | 4.3% | 82.6% |
| Other | 20 | 17.4% | 100% |
| **Location** | | | |
| Germany | 68 | 59.1% | 59.1% |
| USA | 31 | 27.0% | 86.1% |
| Western Europe (excl. Germany) | 13 | 11.3% | 97.4% |
| Rest of world | 3 | 2.6% | 100.0% |
| **Position of Informant** | | | |
| Top management (e.g., Founder/CEO) | 100 | 87.0% | 87.0% |
| Middle Management | 15 | 13.0% | 100.0% |

*Table 1: Descriptive statistics for the responding firms*

# 5. Results

## 5.1 Measurement Models

We used a confirmatory factor analytic approach within AMOS to establish the validity of the measurement model prior to testing the structural model (Brown 2006). First, the individual constructs were assessed. Each item was allowed to load only on the factor for which it was a proposed indicator. The resulting construct reliability was in the range between 0.67 and 0.84, and thus above the required threshold of 0.6 (Bagozzi and Yi 1988). The average variance extracted ranged from 0.50 to 0.57, and thus met the threshold of 0.5. We also examined discriminant validity among the five elements, using Fornell and Larcker's (1981) test. All calculated Fornell-Larcker ratios were below the required value of 1.0, suggesting that there is good discriminant validity between the factors. To assess the fit between the hypothetical model and the sample data, we used relative chi-square ($\chi2/df$), root mean square error of approximation (RMSEA), Tucker-Lewis index (TLI), and comparative fit index (CFI), meeting all threshold values for a reasonable model fit ($\chi2/df = 1.329$, RMSEA = 0.054, TLI = 0.925, CFI=0.940).

Second, to establish the dimensional structure of strategic capabilities for MC, we specified various alternative measurement models at the first-order and second-order levels and assessed their relative fits (Law et al. 1998). The fit statistics for these models are reported in Table 2. Model 1 has a unidimensional factor that accounts for the variance among all 10 items, which is also known as Harman's single-factor test (Podsakoff et al. 2003). Not surprisingly, model 1 has a very poor fit. In model 2, we conceptualize that the 10 items form three distinct and uncorrelated first-order factors, corresponding to SSD, RPD, and CN. Comparison of the fit indices for models 1 and 2 shows that the better-fitting model is 2, indicating that a multidimensional model composed of three uncorrelated first-order factors is superior to a unidimensional first-order factor model. The chi-square difference ($\Delta\chi2 = 114.267$, p < 0.01) across the two models is significant, providing further evidence in support of model 2. Model 3 conceptualizes that the three first-order factors are free to correlate with each other. A comparison between the fit measures of models 2 and 3

indicates that model 3 represents the data considerably better than model 2; the chi-square difference between the two models relative to their degrees-of-freedom difference is also significant ($\Delta\chi2 = 13.589$, $\Delta df = 3$, p < 0.05). Finally, model 4 posits MC capability (MCC) as a reflective second-order construct that accounts for the relationships between the three strategic capabilities. All the second-order factor loadings are significant (p < 0.05). Further, only the second-order factor model has a significant impact on company performance. Collectively, these results suggest that the second-order factor structure is a better statistical specification for modeling MC capability.

The dimensional structure for the performance measures was assessed in a similar manner by comparing two measurement models. Model 5 consists of seven measures forming a unidimensional factor, whereas model 6 consists of two distinct yet correlated factors representing market growth (MG) and customer success (CS). We retain model 6 because of its superior fit to the data (Table 2).

## 5.2 Hypothesis Testing

Our conceptual framework suggests that enhancing any of the three strategic capabilities for MC has a positive effect on company performance. The model in Figure 1 includes the three strategic capabilities and models their pairwise covariance. We label this the direct effects model because it suggests that the strategic capabilities have independent direct effects on market growth and customer success. The fit indices for the direct effects model exceed the critical cut-off values ($\chi2/df = 1.366$, RMSEA = 0.057, TLI = 0.917, CFI=0.933). However, only the structural link from SSD to market growth is positive and significant (0.260, p < 0.05), whereas the other five relationships are insignificant, indicating poor model specification. Therefore, H1 is partially supported, while we do not find support for H2 and H3. Overall, the results suggest that MC firms cannot achieve competitive advantage by improving along only one capability dimension. This finding is somewhat surprising, but it further highlights the importance of examining whether the individual capabilities may affect performance through their complementarity in MC capability.

Complementarity theory implies that the magnitude of the effect of overall MC capability is greater than the sum of marginal effects from developing each capability individually (Milgrom and Roberts 1995). To examine complementarity, we model overall MC capability (MCC) as a reflective second-order factor to capture complementarities aris-

| Models | $\chi^2$ (df) | Normed $\chi^2$ | RMSEA | TLI | CFI |
|---|---|---|---|---|---|
| *Strategic capabilities* | | | | | |
| Model 1 (one-factor model) | 166.053 (35) | 4.744 | 0.181 | 0.470 | 0.588 |
| Model 2 (3 uncorrelated factors) | 51.786 (35) | 1.480 | 0.065 | 0.932 | 0.947 |
| Model 3 (3 correlated factors) | 38.197 (32) | 1.194 | 0.041 | 0.973 | 0.981 |
| Model 4 (one second-order factor) | 38.197 (32) | 1.194 | 0.041 | 0.973 | 0.981 |
| | | | | | |
| *Performance measures* | | | | | |
| Model 5 (one-factor model) | 66.960 (14) | 4.783 | 0.182 | 0.689 | 0.793 |
| Model 6 (two-factor model) | 20.128 (13) | 1.548 | 0.069 | 0.955 | 0.972 |

*Table 2: Measurement models and fit statistics*

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ing from the three capabilities. This reflective second-order factor accounts for multilateral interactions between the three capabilities and is thus a superior statistical specification compared to pairwise interactions (Whittington et al. 1999). The use of a reflective second-order factor to represent complementarities among first-order factors is consistent with recent examinations of complementarity (Tanriverdi and Venkatraman 2005; Shah and Ward 2007; Lichtenthaler 2009; Mishra and Shah 2009). A formative second-order factor modeling approach is not appropriate for capturing complementarities because it does not assume any interactions or co-variance among the first-order factors (Tanriverdi 2006). The complete structural model representing our conceptual framework is shown in Figure 2. We label this the complementarity model.

In assessing the performance effects of complementary strategic capabilities, the complementarity model must be compared with the direct effects model (Whittington et al. 1999): First, the complementarity model with its second-order factor is more parsimonious than the direct effects model because it requires fewer parameters to be estimated and accounts for the covariance among first-order factors. Second, the fit statistics for the complementarity model are also better than those of the direct effects model ($\chi^2/df$ = 1.314, RMSEA = 0.052, TLI = 0.929, CFI=0.941). More importantly, all structural links in the complementarity model are positive and significant, whereas only one structural link was significant in the direct effects model. Finally, we also compare the variance explained in the two performance measures by the complementarity and direct effects models. The complementarity model explains 26% ($R^2$ = 0.263) of the variation in MG compared to 12% ($R^2$ = 0.115) explained by the direct effects model. The variation explained in CS is 16% ($R^2$ = 0.159) for the complementarity model and 7% ($R^2$ = 0.066) for the direct effects model. This result clearly demonstrates the superiority of the complementarity model over the direct effects model in explaining the variation in company performance of MC firms. H4 proposed that the three strategic capa-

bilities are complementary and have a major impact on market growth and customer success through MC capability; our results provide significant support for this proposition. Equally, H5, proposing that MC is meta-capability (higher order construct) also has been supported.

Common method variance (CMV) is a serious concern in survey-based research, especially where the predictor and criterion variables are perceptual and obtained from the same source. To assess this bias we follow recommendations by Podsakoff et al. (2003) When controlling for CMV, the variance explained in market growth even increases from 26.3% to 33.3%, whereas the variance explained in customer success decreases just slightly from 15.9% to 13.0%. Overall we conclude that CMV is not of concern in our study.

## 6. Discussion

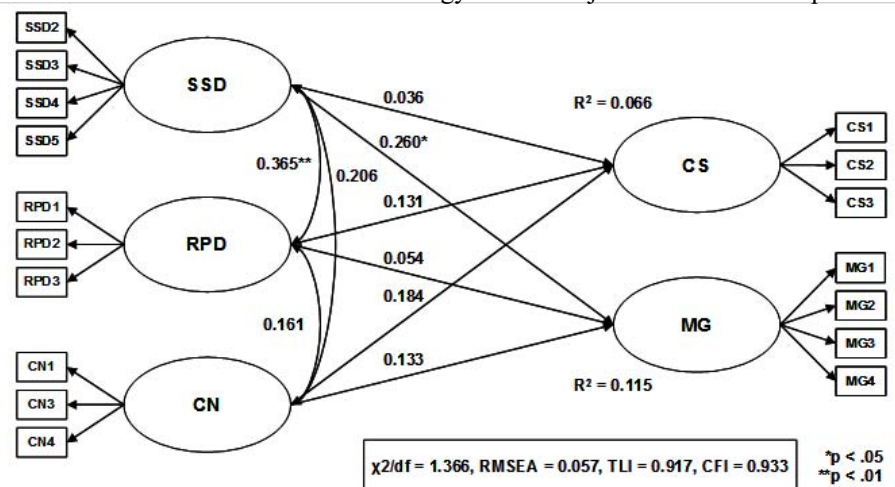Our study confirms that a mass-customization-based ecommerce strategy does not just demand the imple-



$\chi^2/df$ = 1.366, RMSEA = 0.057, TLI = 0.917, CFI = 0.933    *p < .05
**p < .01

*Figure 1: Direct effects model*



$\chi^2/df$ = 1.314, RMSEA = 0.052, TLI = 0.929, CFI = 0.941    *p < .05
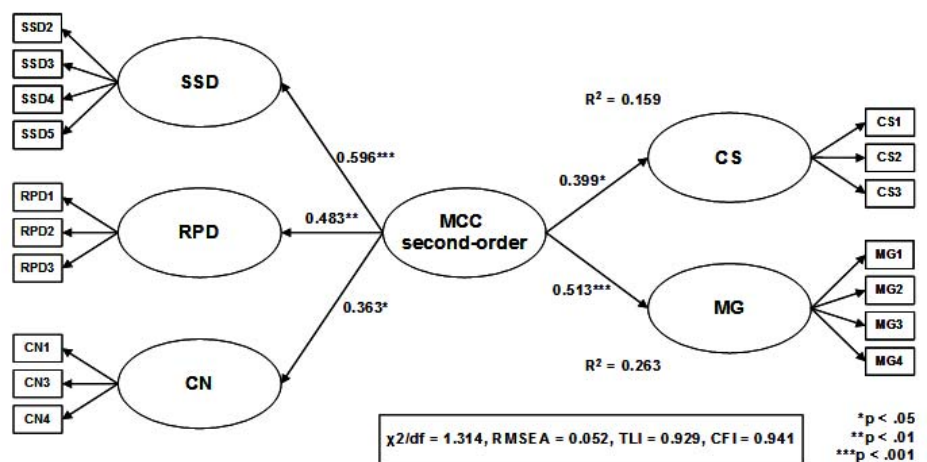**p < .01
***p < .001

*Figure 2: Complementarity model*

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mentation of latest web-technology and configuration software. For our domain of study, BtoC companies offering customizable (tangible) products, these technologies for choice navigation have to be complemented by capabilities enabling solutions space definition and robust processes. We further find that these capabilities do not improve corporate performance on their own. Conceptualizing individual dimensions of a multi-dimensional construct such as MC capability as independent may lead to inconsistent or ambiguous results (however this is exactly the perspective of most of the previous research on MC that has studied the phenomenon from a disciplinary perspective).

By modeling their complementarity using a second-order construct, we discovered synergies arising from the simultaneous implementation of the three strategic capabilities for MC. In other words, the "marginal productivity" of each capability increases with the values of all other strategic capabilities. Other researchers report similar findings for analyses of organizational learning processes of absorptive capacity (Lane et al. 2006) and routines used for collaboration in new product development (Mishra and Shah 2009). Thus, the results confirm that no MC ecommerce company is likely to outperform its rivals based on a single strategic resource (e.g, an advanced configuration toolkit). Gaining superiority in competitive environments is instead dependent on a set of mutually enhancing strategic elements (Carmeli and Tishler 2004). Overall, this study is a step toward providing a more nuanced and realistic perspective on the integrated nature of MC-based ecommerce.

These results may also explain the large failure rate of established incumbents, as mentioned at the beginning of the paper, in implementing MC. While many large consumer goods companies have a MC operations, to our knowledge only very few really could scale it up beyond pilot state. The results from our research indicate that this may be a typical case of organizational inertia to change, given the need not to just implement a few technologies or approaches, but an entire set of complementary routines and practices underlying the capabilities. Our results hence call for future research to examine how firms coordinate the three MC capabilities to achieve complementarities. Which organizational structures and processes can be designed to leverage a complementary set of capabilities? Do certain characteristics of entrepreneurs and employees (e.g., personality, attitudes) help or hinder the development of strategic MC capabilities? Further work on such central questions may allow us to better understand how organizations should be designed to capture value from capabilities-based synergies. Similarly, we did not consider any cost of capability development (or acquisition) and utilization. Achieving a capability involves integrating tangible assets, knowledge, and skills, which makes it difficult to possess a capability without incurring some costs (Helfat et al. 2007). For example, a robust process design capability utilizes shop floor employees, engineers, and their knowledge, as well as physical assets such as flexible manufacturing and design technologies. This means that capability performance has two dimensions: quality and cost; that is, how well the capability performs its intended function and how much it costs to perform at a certain level. Thus, future studies may address the costs of capability development and examine potentially declining marginal returns to the three MC capabilities.

Methodologically, our study addresses the lack of empirical evidence in MC research on the firm level lamented by several researchers (Tu et al. 2004; Kumar et al. 2007; Moser 2007; Huang et al. 2010). We contribute to this call for research by selecting a unique sample of "pure play" mass customizing companies. In addition, we address another important reason for the lack of research: substantive disagreement about what constitutes MC and how it can be measured operationally (Kaplan and Haenlein 2006). Therefore, as a first contribution, this study develops a set of valid and reliable instruments to measure the three MC capabilities as conceptualized by Salvador et al. (2009). These instruments were developed through a carefully designed data collection process applying rigorous instrument development methods and showed strong evidence of unidimensionality, reliability, convergent validity, and discriminant validity. The scales thus represent substantial progress towards the establishment of standard instruments for measuring MC capability and its sub-dimensions. These instruments will allow researchers to assess the state of MC implementation in firms and test hypotheses about relationships between MC capabilities and other firm characteristics affecting firm performance. Additionally, the study provides a tool for managers to self-evaluate their progress in implementing capabilities-based MC and compare MC readiness among various divisions of the same company or across.

Our study also has important implications for managers of ecommerce companies. First, our results empirically demonstrate that firms need to develop distinguish MC capabilities. Managers, first of all, have to develop a detailed understanding how the three capabilities can be translated for their businesses and which distinct set of activities builds each capability in their industry. While previous research is providing good managerial advise about RPD (e.g., Broekhuizen and Alsem 2002; Brown and Bessant 2003; Kotha 1996; Tu et al. 2004; Zhang et al. 2003) and CN (e.g., Dellaert and Dabholkar 2009; Gownder 2011; Merle et al. 2010), corresponding research is lacking for SSD. We hence remind managers to particularly focus on those activities that help them in understanding where their customers want choice and what particular customization options may drive cus-

tomer value. To obtain this information, firms may engage in market research. But also analyzing past configurations (configurator log files) may be a good strategy to continuously adjust a firm's solution space.

But the main message managers shall take from our research is that pursuing MC demands to have all three capabilities in place to achieve an above-average performance relative to their competitors. The lack of significance of the individual direct effects on company performance suggests limitations in one capability can be not compensated by excelling at the other capabilities. We therefore advise managers, especially of startups entering the MC market, not to place too much emphasis on any single particular capability, and rather encourage them to balance the development of the three capabilities. We have seen quite some companies in our sample which were excellent in, say, CN, focusing on great ecommerce configurator tools and providing great customer experience during the online sales process. But these companies ultimately failed as this promise could not being fulfilled by efficient and effective processes. Therefore, to evaluate their progress in implementing MC, managers should define key performance indicators (KPIs) for each capability and regularly benchmark them. This will allow them to identify the strengths and weaknesses of their current MC system and allocate their limited resources more efficiently. The scales and measures used in this study may provide a good starting point for developing meaningful KPIs.

In summary, a complementary set of MC capabilities provides unique value because it is difficult to disentangle from a purely outside perspective and therefore hard to imitate (Porter 1996)—and even if competitors successfully detect the complementarities, they will have difficulties replicating them. This implies that a firm embarking on MC should not blindly copy the business models of successful mass customizers. Instead, it should define its own specific MC strategy based on idiosyncratic customer requirements, the competitive intensity in the industry, and the available technology (Salvador et al. 2009).

## 7. Limitations and Future Research

Our study is not without limitations. First, it is important to recognize that a single study cannot provide valid measures in the true spirit of instrument development (Zhang et al. 2003). Future studies should collect additional data to confirm both the strategic capabilities measures and the structural model results. A second concern is the generalizability of the study, which may be limited due to the sample characteristics. The sample consists mainly of innovative SMEs employing business models predicated completely on MC. Therefore, the results may not be directly transferable to traditional mass producers moving into customization, who are ac-

customed to operating in accordance with traditional management concepts. Accordingly, we encourage future studies to investigate managerial challenges of traditional mass producer adopting MC in developing the three strategic capabilities. Moreover, we only tested our hypotheses for B2C relations. This does not mean that the capabilities framework is not applicable to B2B relations. A study that focuses on B2B relationships could therefore be useful. For instance, we would expect to find a higher degree of flexible automation and more technically oriented configuration toolkits among B2B mass customizers.

Thirdly, the strategic capabilities were analyzed only from a vendor's point of view; they were not examined from an external perspective. However, Zhang et al. (2003) emphasize that customers do not value the capabilities directly. They are unwilling to pay more because a firm scores high on the respective capability dimensions. Customers rather value the manifestation of these capabilities, which is the ability of a firm to supply a high variety of products in good quality, at a reasonable cost, and at the right time. It would therefore be insightful to apply a dyadic research design and contrast the self-assessments of the firms in the sample with customer evaluations of the manifestations of the three capabilities. Matching firm data with performance data obtained from business intelligence or web mining (revealing customer behavior and preferences in online configurators) could provide very interesting insights.

Finally, this study employs a cross-sectional analysis of a large number of MC firms. While this provides important insights into the determinants of a MC capability, it does not allow any conclusions about the sustainability of the capability configuration. This is particularly true given the fact that the majority of companies (84.3%) in the sample are younger than five years. An important step for further research thus is the collection and analysis of longitudinal data. The cross-sectional design also fails to shed light on the change process involved in developing and improving MC capabilities. For example, a relatively low level of robust process design capability may in fact lead managers to alter certain antecedents such as process architectures, manufacturing technologies, or qualification of the workforce, which in turn may increase the level of robust process design capability. In this regard, it would be useful to conduct in-depth studies of a few organizations so as to better understand the factors that drive the change efforts directed at improving the MC capabilities of a business.

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## Appendix: Measures

Due to space constraints, we cannot print the measurement instrument used in this paper in full size. Please contact the first author with a reference to the conference in order to obtain a full scaled version via e-mail.

**Construct: Solution Space Development (SSD); Cronbach's $\alpha$ = 0.816; AVE = 0.584**

| Items* | | Item-to-total |
|---|---|---|
| SSD1 | We constantly monitor changes in our customers' needs and preferences for variety. | 0.478 |
| SSD2 | We are able to determine exactly how much variety is requested by our customers. | 0.660 |
| SSD3 | We are able to identify along which product attributes customers' preferences differ the most. | 0.744 |
| SSD4 | We continuously adapt the product variety offered to changing customer requirements. | 0.593 |
| SSD5 | We have developed routines to determine the optimal amount of product variety we offer. | 0.576 |

*All items were rated on 5-point Likert scale and anchored "strongly disagree – strongly agree"

**Construct: Robust Process Design (RPD); Cronbach's $\alpha$ = 0.758; AVE = 0.521**

| Items | | Item-to-total |
|---|---|---|
| RPD1 | We can operate efficiently at different levels of output. | 0.545 |
| RPD2 | We can operate profitably at different production volumes. | 0.597 |
| RPD3 | We can produce different products in the same plant at the same time. | 0.616 |
| RPD4 | We can quickly change the quantities of our products produced. | 0.513 |
| RPD5 | We can change over quickly from one product to another. | 0.394 |

*All items were rated on 5-point Likert scale and anchored "strongly disagree – strongly agree"

**Construct: Choice Navigation (CN); Cronbach's $\alpha$ = 0.702; AVE = 0.629**

| Items* | | Item-to-total |
|---|---|---|
| CN1 | We are able to effectively navigate our customers through the customization process. | 0.519 |
| CN2[a] | We provide customers with realistic visualizations of their product configurations. | 0.383 |
| CN3 | We allow customers to conveniently compose products to their specific needs. | 0.511 |
| CN4 | We enable our customers to find the optimal product configuration without confusing them. | 0.524 |
| CN5[a] | We provide guidance and support to our customers throughout the entire product configuration process. | -- |

*All items were rated on 5-point Likert scale and anchored "strongly disagree – strongly agree"
[a] Item was deleted in further analysis.

**Construct: Customer Success (CS); Cronbach's $\alpha$ = 0.667; AVE = 0.616**

| Items | | Item-to-total |
|---|---|---|
| CS1 | Achieving customer satisfaction | 0.542 |
| CS2 | Keeping current customers | 0.494 |
| CS3 | Providing value for customers | 0.462 |

*All items were rated on 5-point Likert scale and anchored "much worse relative to main competitors – much better relative to main competitors"

**Construct: Market Growth (MG); Cronbach's $\alpha$ = 0.839 AVE = 0.685**

| Items | | Item-to-total |
|---|---|---|
| MG1 | Attracting new customers | 0.760 |
| MG2 | Attaining desired growth of customer base | 0.737 |
| MG3 | Securing market share | 0.589 |
| MG4 | Achieving sales growth | 0.627 |

*All items were rated on 5-point Likert scale and anchored "much worse relative to main competitors – much better relative to main competitors"