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Abstract

Purpose – This paper aims to propose a method to determine which mass customization (MC) characteristics should be prioritized in mass-customized service design.

Design/methodology/approach – Looking at manufacturing MC systems and conducting a literature review, it is not possible to observe a methodological step to define customized service design as the one we propose in this work. Results show a systematic classification of MC characteristics based on MC enablers and service enablers. These enablers are related by a quality function deployment (QFD) matrix and rewritten using a reverse QFD procedure.

Findings – In the end, it was possible to determine which characteristics should be prioritized in mass-customized services.

Research limitations/implications – Two case studies were performed: one with an electric power supplier and another one with a university.

Practical implications – It shows that despite easy customization, organization is not always interest in service features customization. The explanation in these two cases is customization cost, which compared to the benefit does not seem advantageous for the organization.

Originality/value – This paper creates a methodology to design a first phase in customized services in Latin American services and that is the original contribution.

Keywords Mass customization, Classification, Service

Paper type Case study

Introduction

Mass customization (MC) has aroused continued interest of academics and practitioners due to its contribution to the operation and management of organizations on an

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everyday basis. However, even though MC has potential solutions to the manufacturing sector, with well-founded studies on supply chain (Abdelkafi *et al.*, 2010), market analysis and product structure planning (Spring and Araujo, 2009) and production planning and control (Zhang and Chen, 2006; Tseng and Radke, 2010; Lee and Daí, 2010), questions exist about its actual applicability on service sector (McCarthy *et al.*, 2010).

These questions arise, on the one hand, because of the subjective nature of the term *MC* and, on the other hand, because of the peculiarities of service management, with its distinct characteristics. It is widely known that the concept of MC has been used in different contexts, both in the service and manufacturing sectors. However, the applicability of this concept renders the term MC multifaceted, and even if it is complementary, there exist some differences in relation to the original concept. For instance, terms such as manufacturing strategies, service delivery, changes in the supply chain and marketing planning are commonly found in the literature. According to Davis (1987), MC originally refers to a business strategy aimed at giving individual customers what they want, when and how they want it. Conceptually, MC can be construed as a business strategy that discriminates between organizations in highly competitive environments, adding more qualification to market segmentation (Helo *et al.*, 2010).

In this paper, MC is understood as a production strategy that allows offering a variety of products and services that meet customer needs and have similar costs to mass-produced ones. The offering of a large amount of products and services guarantees that a firm will be able to cater to individualization requirements, the first element of the customization/mass production dichotomy. Similar costs to those of mass-produced products allow for the fulfillment of the second element: production at a cost that rationalizes the manufacturing operation and service delivery. This definition is used to guide the discussions in this paper, but it should not be viewed as conclusive.

Despite the evolution of the original concept, the conceptual solution for the service sector is still in its infancy (Peters and Saidin, 2000). This is so because the service sector has high levels of intangibility, perishability, inseparability and variability (Zeithaml, 1981), concepts that are not always present in manufacture, where MC studies originated. Therefore, customized services are characterized mainly by heterogeneous market demands, speed and diversification demanded from customers in this type of segment and competition with firms in the same segment (Cao *et al.*, 2006). This, coupled with the level at which customization may occur (Pan and Holland, 2006; Silveira *et al.*, 2001), eventually severs the link between services and MC.

As a matter of fact, the field of customized services uses the characteristics of MC manufacturing; hence, customization characteristics are not classified from the perspective of services. An approach to obtain the characteristics of customized services would be to use manufacture characteristics and verify which of them could be used for "mass-customized services" (McCarthy *et al.*, 2010). In this respect, the aim of the present paper is to develop a system to determine which MC characteristics must be prioritized in the mass-customized service design. To do that, customization characteristics are classified in terms of importance for the implementation of customized services, using MC enablers and service enablers as criteria, combined into a matrix of relationships that is characteristic of quality function deployment (QFD), corrected by the reverse QFD procedure, as proposed by Fogliatto *et al.* (2008). Thereafter, two case studies were conducted to test the efficiency of the matrices.

Theoretical background

The MC literature in the service sector underscores the development of models targeted at linking consumers to the service planning stages. Some important studies on this issue are shown in what follows.

Cao *et al.* (2006) devised a method for service customization. Their method defined a customization routine based on the sales of air tickets, which assessed the purchase of each customer, using it to remodel the service structure. Their study showed the strategic and quality impacts on the characteristics of a customized service, in addition to a classification system for the services customers requested from the airline companies.

Helms *et al.* (2008) advocate service customization through electronic commerce, but they did not present a customization method or model for it. In their work, they associate the use of Internet with the intangible aspects of the service in an attempt to explain how integrated systems, product innovation, performance measurement, organization strategy and cost minimization are important for service delivery. The authors conclude that the use of Internet tools and of customer information (using database storage) provides customized services with a competitive edge. Such a model could also be used to define the strategy of a customized service, as proposed herein. However, in the model of Helms *et al.* (2008), there is no information that allows for or indicates this application.

Jin *et al.* (2012) discuss service customization, using the elaboration of a travel package as example. In a sample of 220 cases submitted to a discriminant analysis, it was possible to realize the importance of increasing or reducing service customization. A logistic regression model, made up of behavioral and psychological variables, informs the essential and peripheral features for the supply of the customized service. Their results corroborate that a larger customization of the service can improve customer satisfaction and loyalty. Conversely, a larger customization also implies higher costs for those who supply it.

Grenci and Watts (2007) proposed a structure to associate customized sales with customized production. For the authors, customized production relies on the existence of information systems, modularity and interconnectivity; customized sales have three corresponding classes: information for decision-making, aggregation and electronic commerce. Thus, a direct relation was established between the sets of manufacture and sales characteristics, leading to the conclusion that customized sales depend on the market segment and on its growth potential, on the customers, as well as on their experience and behavior, and on the quality of data collected from the customers by the sales service.

Bask *et al.* (2010) developed a model in which stages of the logistic service chain are analyzed as modules of a process, making them customizable within this process. From the model, customer demands are turned into processes, which are grouped into modules of logistic services, thus allowing for customization of the delivery service. The model, however, does not allow measuring customization efficiency and is indicated only for determining the strategy to be used in the organization.

Tang *et al.* (2010) proposed a structure that describes the customer's purchasing decision for customized products and services. This structure is based on 6 categories and 24 subcategories used to assess customization, its determinants and its consequences. Results show that the mass-customized services can be organized into six stages, among which, the first one is the major contribution of the present study. The

first stage is where knowledge is built, establishing a permanent relationship between customers and the company, with the collection of preliminary information for the development of the service. The remaining stages follow the traditional logic of problem solving in service development, going from the initial stage of problem identification to the final stage of delivery of customized service.

Other studies discuss service customization in a more superficial fashion. Jiao *et al.* (2003) understood service customization as a stage of the service delivery process, which can be adapted to customer specifications at the moment the service is rendered. Shamsuzzoha *et al.* (2009) showed that service customization should be added as an integral part of the supply chain, in which the suppliers of inputs used in service delivery offer individualized products. O'Shaughnessy and O'Shaughnessy (2009) understood service customization as a way to develop competitiveness, enticing the customer for good. For Gottfridsson (2010), service customization occurs, as organizations design the service through the use of business-to-consumer systems, which are part of the service designing process. For Buffington (2011), service customization is a type of market segmentation, which derives from the mass supply of a given product.

None of the analyzed studies included a phase in which the customized service is assessed from the perspective of customization characteristics. These customized service characteristics can be understood as a set of variables that must be prioritized in the implementation of the customized service, varying according to the perspective or strategy of a given company. The aim of this study is to define this system, given that it consists of a stage that supports the design of the previously mentioned customized service models.

Materials and methods

The Emerald, Sage, ScienceDirect, Springer – Verlag and Kluwer databases were searched to verify the MC characteristics. The search used *MC* as a keyword; the search period was limited to 1990 through 2010. This time restriction is related to the fact that the term *MC* was first used in 1987, and there are no publications on this topic before that. The obtained articles were systematically reviewed to determine which of them would be included in the present study.

In total, 13 customization characteristics were identified in 83 articles. Table I clearly shows the characteristics associated with MC. The description of the characteristics focused on services, maintaining the original concept of each article it was taken from.

The most frequent characteristics are associated with the definition of service structure (C1), with the use of adaptable projects and processes (C2), with the types of tools and strategies (C11) and with the fulfillment of customer needs (C3), which were found in 43.5, 32, 29 and 23 per cent of the publications, respectively.

In turn, customization enablers indicate what is necessary to implement MC and were obtained from Fogliatto *et al.* (2012). For the better understanding of these enablers, they are split into four categories: methodologies, processes, manufacture technologies and information technologies.

The *methodologies* enabler refers to high process agility – meeting time restrictions, and to the generation of customization requirements that follow lean principles, maximizing integration and minimizing loss (Fogliatto *et al.*, 2012). In this respect, the use of principles and concepts associated with lean and agile strategies are relevant for the implementation of MC.

Characteristics		References
C1	The structure/architecture of services organized into families, platforms, modules and components	Tseng and Jiao (1996), Jiao and Tseng (1999), Muffatto (1999), Dahmus *et al.* (2001), Simpson *et al.* (2001), Gershenson *et al.* (2003), Simpson (2004), Zha *et al.* (2004), Corbett and Rosen (2004), Jiao and Tseng (2004), Jose and Tollenaere (2005), Huang *et al.* (2005), Zhang *et al.* (2005), Marion *et al.* (2006), Simpson *et al.* (2006), Thevenot and Simpson (2006), Dai and Scott (2007), Huang *et al.* (2007), Jiao *et al.* (2007), Alizzon *et al.* (2007), Mun *et al.* (2007), Willians *et al.* (2007), Fixson (2007), Li *et al.* (2008), Ni *et al.* (2008), Lindquist *et al.* (2008), Kumar (2008), Kumar *et al.* (2008), Salvador *et al.* (2009)
C2	Adaptable designs obtained from customized processes	Tseng and Jiao (1996), Jiao and Tseng (1999), Duray *et al.* (2000), Dahmus *et al.* (2001), Duray (2002), Karlsson (2002), Piller (2004), Jiao and Tseng (2004), Corbett and Rosen (2004), Zha *et al.* (2004), Gershenson (2004), Zhang *et al.* (2005), Jose and Tollenaere (2005), Pan and Holland (2006), Dai and Scott (2007), Alizon *et al.* (2007), Ismail *et al.* (2007), Apeagyei and Otieno (2007), Williams *et al.* (2007), Lindquist *et al.* (2008), Bare and Cox (2008), Li *et al.* (2008)
C3	Integration of customers into the service process, allowing total fulfillment of their needs and expectations	Duray *et al.* (2000), Da Silveira *et al.* (2001), Connell *et al.* (2002), Bardakci and Whitelock (2003), Siddique and Boddu (2004), Zha *et al.* (2004), Bardakci and Whitelock (2004), Piller *et al.* (2004), Piller (2004), Bardakci and Whitelock (2005), Sigala (2006), Williams *et al.* (2007), Wang and Lin (2008), Haug *et al.* (2009), Cho and Fiorito (2009), Spring and Araujo (2009)
C4	Marketing planning and service marketing	Duray *et al.* (2000), Connell *et al.* (2002), Bardakci and Whitelock (2003), Mun *et al.* (2007), Endo and Kincade (2008)
C5	Information systems that work as communications channels	Jiao and Tseng (2004), Piller (2004), Siddique and Boddu (2004), Jiao *et al.* (2007), Alizon *et al.* (2007), Ma *et al.* (2008), Ni *et al.* (2008), Lindquist *et al.* (2008), Fogliatto and da Silveira (2008), Feng *et al.* (2008)
C6	Supply chain customization	Hoek (2001), Salvador *et al.* (2002), Yang (2004), Pan and Holland (2006), Huang *et al.* (2005), Huang *et al.* (2007), Lindquist *et al.* (2008), Jitpaiboon *et al.* (2009)
C7	Data management, configurations and service delivery stages	Jiao and Tseng (1999), Ni *et al.* (2008), Liou *et al.* (2010)
C8	Determination of costs per activities	Piller *et al.* (2004), Chen and Wang (2007)
C9	Integration between service planning and the goals of the organization	Duray *et al.* (2000), Duray (2002), Salvador *et al.* (2002), Brown and Bessant (2003), Jiao and Tseng (2004), Du *et al.* (2005), Alizon *et al.* (2007), Lindquist *et al.* (2008), Jitpaiboon *et al.* (2009), Starr (2010)
C10	Agile and quick service delivery	Silveira *et al.* (2001), Brown and Bessant (2003), Ismail *et al.* (2007)

(*continued*)

Table I. MC characteristics identified in the literature

Characteristics		References
C11	Tools (concurrent engineering, hybrid systems, etc.) and production strategies (lean production, mass production, etc.)	Kotha (1995), Muffatto (1999), Hoek (2001), Salvador *et al.* (2002), Karlsson (2002), Piller *et al.* (2004), Simpson (2004), Bardakci and Whitelock (2005), Jose and Tollenaere (2005), Zhang *et al.* (2005), Zhang and Chen (2006), Simpson *et al.* (2006), Mun *et al.* (2007), Kincade *et al.* (2007), Apeagyei and Otieno (2007), Alizon *et al.* (2007), Jiao *et al.* (2007), Ni *et al.* (2008)
C12	Knowledge creation through information feedback	Kotha (1995), Zha *et al.* (2004)
C13	Reproducibility, standardization, prototyping and individualization techniques	Tseng and Jiao (1996), Bardakci and Whitelock (2004), Piller (2004), Bare and Cox (2008), Piller (2008), Kumar (2008)

Table I.

The *processes* enabler is subdivided into five items. The first one, called *order elicitation*, associates the search for customer information through the use of structured collection tools and data interpretation to determine product configuration. The second one, *postponement*, indicates the time and the form of delay in product customization during the production process: time indicates the delay associated with the order entry and delivery of the product to the customer, and form indicates how different features are added to the product. *Product platform* is the third item. According to Fogliatto *et al.* (2012), product platform is a common base that consists of shared routines, activities and objects, which remain constant, as new products are manufactured. The literature gives a detailed account of how these platforms are designed, each of which with a specific purpose. The *manufacture* item demonstrates how the planning and control of the manufacture of customized products should be like, including tools, machines, setups and cycle times (Jiao *et al.*, 2007). Finally, the *supply chain* item presents the make-to-order and make-to-stock processes, explaining how the stages of product manufacture must be conducted until customized products are obtained.

The *manufacture technologies* enabler focuses on product design (Nielsen and Cox, 2008). In this case, tools such as computer-aided design (CAD), flexible manufacturing system (FMS), computer-integrated manufacturing (CIM) and computer numerical control (CNC) end up replaced by prototyping techniques, such as the use of laser scanning with CAD systems for the creation of the initial prototype instead of the creation of the virtual prototype by CAD.

Finally, the *information technologies* enabler refers particularly to the integration of internal information flow in the organization and the firms' need to add information from the customers to the products (Fogliatto *et al.*, 2012). The role of information technology for MC lies in including the customer in the product configuration and specification and even in the designing stage (Dietrich *et al.*, 2007). The greatest contribution of information technologies is that they increase the satisfaction of customers and the knowledge about their preferences (Dean *et al.*, 2009). Concomitantly, information technologies support customer options about their purchases and the firm's decisions about price, design, manufacture planning and supply chain management.

Based on expert opinions, it was possible to define the strength between enablers and customization characteristics, as shown in Table II.

Thereafter, experts were asked to relate customization enablers to dimensions that characterize services. According to Zeithaml (1981), among others, services consist of four dimensions: intangibility, perishability, variability and inseparability. Intangibility means that, in services, the process is the product (Kotler and Keller, 2006). Because of that, service consumers seek evidence of service quality, such as premises, personnel, equipment, advertising material and price (Booms and Bitner, 1981; Levitt, 1991). Perishability corresponds to the incapacity to stock services. Thus, managers of service suppliers should promote actions that try to strike a balance between supply and demand, such as price differentiation, promotional strategies, additional services and reservation mechanisms (Fitzsimmons and Fitzsimmons, 2010). Variability depends on the effect of service delivery on people. This way, organizations that operate in this sector should invest in hiring and training compatible with the firm's posture, standardize service delivery and monitor customer satisfaction (Zahaj and Griffin, 2002). Finally, inseparability refers to simultaneity between service provider and consumer, which is almost always necessary (Lovelock *et al.*, 2011).

With the literature review at hand, experts were asked to relate customization enablers to service dimensions. The results regarding mean expert opinions are shown in Table III.

The group of experts from which Tables II and III results were obtained is characterized by people who work every day with research into services and MC. The eight experts include six researchers with a PhD in Engineering and Business Administration and two doctoral students in Production Engineering.

The second part of the study assessed two cases: an electric power supplier and a university that uses a specific teaching method. The aim of the studies was to identify MC enablers and characteristics that should be prioritized to obtain customized services. This was done by determining the demands for customization faced by firms and the relationships established in Tables II and III. The conventional QFD and the reverse QFD analyses, proposed by Fogliatto *et al.* (2008), were used. Both analyses are described in what follows.

QFD is a method for product development designed in Japan in the early 1960s. Two approaches to the implementation of QFD are widely described in the literature: the model of Akao (1996) and the American Supplier Institute (ASI) model, introduced by Cohen in 1995 and used in the present paper.

The ASI model consists of four interlinked matrices (I-IV). Matrix I establishes the relationship between customer demands and product characteristics. Matrix II relates product characteristics to its components. Matrix III relates components of the products to the stages of manufacture. Matrix IV relates the stages of the process to the planning of operations. All matrices follow the same analytical pattern. Consider a matrix with I items in the rows (e.g. customer demands for the product) whose weights of importance are represented by a vector $\boldsymbol{w}$ of size $(\boldsymbol{I}(1)$, with elements $\boldsymbol{w}_i$ and J items in the columns (e.g. measurable product characteristics). At the center of the matrix, where rows and columns intersect, analysts are asked to assess the impact of the items in the columns on the items in the rows, often using a numerical scale from zero to nine or from zero to five. Let $r_{i,j}$ be the impact of the item in the j-th column on the item in the i-th row, corresponding to the element (i,j) of a matrix of relationships $\mathbf{R}$ of size $(\boldsymbol{I}(\mathrm{J})$. By analyzing

Table II.
Relationship between customization characteristics and enablers

Mass customization characteristics		Customization enablers							
		Methodologies	Order elicitation	Postponement	Processes product platform	Manufacture	Supply chain	Information systems and technologies	Manufacturing technologies
C1	The structure/architecture of services organized into families, platforms, modules and components	5.17	7.67	6.50	8.00	7.00	6.50	6.83	6.67
C2	Adaptable designs obtained from customized processes	7.00	6.67	7.00	7.83	7.17	7.33	6.83	6.83
C3	Integration of customers into the service process, allowing total fulfillment of their needs and expectations	5.33	8.67	6.50	6.00	5.33	5.00	8.17	6.33
C4	Marketing planning and service marketing	5.33	7.33	5.17	6.67	5.33	4.00	7.33	5.00
C5	Information systems that work as communications channels	4.83	8.50	6.17	5.17	5.83	6.50	9.00	6.50
C6	Supply chain customization	6.17	6.17	5.33	5.50	6.50	9.00	6.50	6.00
C7	Data management, configurations and service delivery stages	5.67	6.50	5.00	6.33	8.33	6.00	7.67	7.50
C8	Determination of costs per activities	6.33	3.50	5.17	5.50	5.83	4.50	5.00	6.17
C9	Integration between service planning and the goals of the organization	6.17	5.00	4.17	5.67	5.50	4.67	5.17	3.83
C10	Agile and quick service delivery	7.17	6.67	6.17	6.83	7.67	6.17	7.00	5.83
C11	Tools (concurrent engineering, hybrid systems, etc.) and production strategies (lean production, mass production, etc.)	7.50	4.67	5.00	7.33	7.17	5.00	5.50	6.67
C12	Knowledge creation through information feedback	5.00	7.50	5.67	5.00	4.67	5.50	8.17	6.00
C13	Reproducibility, standardization, prototyping and individualization techniques	7.33	5.17	4.67	7.67	7.33	4.83	5.17	7.67

a QFD matrix, one intends to obtain a vector of priorities of size ($J(1)$ for the items in the columns; this vector is designated by **p** and given by:

$$p = R^t w, \tag{1}$$

where $\mathbf{R}^t$ designates the transpose of **R**.

The operations with the QFD matrices evolve from Matrix I to Matrix IV. The information is transferred during these operations, and the last matrix summarizes the results of the analyses conducted in all previous matrices. For example, the items in the columns of Matrix I (i.e. product characteristics), together with the vector of priorities, become the items in the rows of Matrix II, whose columns contain the components of the product. The analysis in Matrix II follows the same steps previously described for Matrix I. The exposition above highlights the interrelationship between the matrices, which share some of the information in the analysis.

Weights of importance and of priority in QFD matrices can be modified to represent the important characteristics of the product being developed and of its manufacturing process. Consider, for instance, Matrix I, with weights of importance associated with the items in the rows distributed in a vector $\boldsymbol{w}^I$ with elements $\boldsymbol{w}_i^I$ (i.e. weights of importance given by customers to the demands for the product). The weights in $\boldsymbol{w}^I$ can be changed, for example, to represent the strategic importance associated with the fulfillment of the demands. Thus, if $\boldsymbol{s}_i^I$ designates a measure of strategic importance ranging from 0.0 (not important at all) to 2.0 (extremely important), the weight $\boldsymbol{w}_i^I$ would be changed so as to denote the strategic importance using the following equation (Akao, 1996):

$$\tilde{w}_i^I = w_i^I \times \sqrt{s_i^I}, \tag{2}$$

where $\tilde{w}_i^I$ designates the modified weight and $\tilde{w}^I$ is the vector of modified weights. The scale for measurement of strategic importance and the weight correction proposed in equation (2) follow an easily understandable pattern. All the weights of the QFD matrices can be changed analogously to include aspects that were not contemplated by equation (1), if desired.

In the analysis of the reverse QFD (Fogliatto *et al.*, 2008), the aim is to retrieve the vector **w** from **p** and **R** informed by the analyst. This reverse operation can be carried out by applying the equation below to a given QFD matrix:

Mass customization enablers	Service dimensions			
	Intangibility	Perishability	Variability	Inseparability
Methodologies	3.40	4.60	4.60	3.80
Processes				
Order elicitation	3.20	3.20	7.80	7.40
Postponement	3.00	5.60	5.80	4.80
Product platform	3.00	3.60	4.80	4.40
Manufacture	3.20	5.80	4.80	5.80
Supply chain	3.20	5.60	3.80	4.80
Information systems and technologies	4.40	5.00	8.00	7.20
Manufacturing technologies	3.00	3.80	4.00	5.20

Table III. Relationships between customization enablers and service dimensions

$$\hat{w} = (RR^t)^{-1}Rp, \quad (3)$$

where $(\mathbf{RR}^t)^{-1}\mathbf{R}$ is the pseudo-inverse of $\mathbf{R}$. The pseudo-inverse in equation (3) allows retrieving the vector $\mathbf{w}$ in cases where $\mathbf{R}$ is not a square matrix (when $\mathbf{R}$ is a square matrix, $\mathbf{R}^{-1} = (\mathbf{RR}^t)^{-1}\mathbf{R}$). Equation (3) restores $\mathbf{w}$ without any error whenever $\mathbf{R}$ is a nonsingular matrix. Otherwise, the retrieval of $\mathbf{w}$ leads to a vector with a residual error accumulated in its last element; the closer $\mathbf{R}$ is to a square matrix, the smaller the residual error.

In the reverse QFD, the focus is on a situation where the vector of priority weights obtained from normal operations in a given QFD matrix is modified to reflect some situation of interest, using equation (2) or another analogous expression. Let $\tilde{\mathbf{p}}$ be the vector of modified priorities. Replacing $\mathbf{p}$ with $\tilde{\mathbf{p}}$ in equation (3), $\mathbf{w}$ is not retrieved, but a new vector $\hat{\mathbf{w}}$ of weights is obtained, indicating the modifications represented by vector $\tilde{\mathbf{p}}$. Comparing vectors $\mathbf{w}$ and $\hat{\mathbf{w}}$, it is possible to assess the effects of adjustments of $\mathbf{p}$ on the original weights. A similar situation is shown in the case studies in Section 4 of the present paper.

In the case study, the mean result of each column was weighted as a function of the weights of the characteristics determined by the firm which renders the service. These weights were given by the organization that participated in the study and ranged from 1 (not important) to 10 (extremely important). Moreover, the opinion of the firm was crucial to indicate which service dimension should preponderate, which is the basis for the reverse QFD logic. The case studies allowed determining which MC characteristics associated with manufacture are inserted in mass-customized services. Figure 1 shows method steps.

Results

Case description

The case studies used to test the model involve different types of services. One of them was carried out in the works sector of an electric power supplier. This sector is characterized by the high volume of works undertaken on a monthly basis and by the

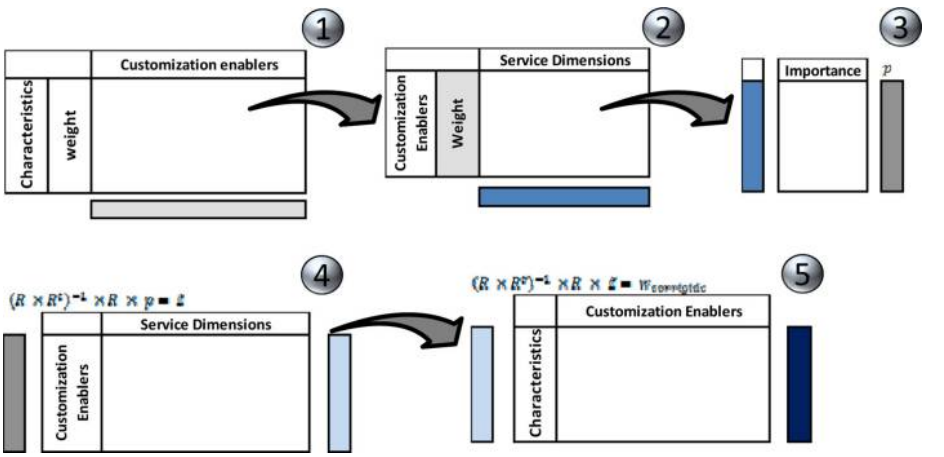

Figure 1.
Method steps

customization of each work. For instance, within the same month, there are construction works for a substation for an industrial district and the installation of a lamppost in a residential area. These works are customized using a set of 2,000 components, provided for by Brazilian laws and sector-specific standards.

The second case was conducted at a university, specifically for the customization of short-duration programs and advanced training programs. These programs are usually indicated for professionals who have finished their undergraduate degree and need upskilling within a short time frame (less than six months). At this university, the programs are organized based on demand patterns, and although the area of knowledge may differ, they are focused on maintaining a semestral volume.

The same methodology was used in both cases. First, the characteristics were sent to the firm. Then, the level of importance of each characteristic and the importance of each service dimension were evaluated. After that, this information was inserted into the devised model, and the role of each service dimension was obtained for the MC characteristics. To achieve that, the reverse QFD process was used based on each service dimension considered to be the most important by the respondent.

The data collected from the first and second case studies are shown in Table IV. Note that the assessed organizations determined the importance of each characteristic. These data are used to start the QFD process, which, later, allow for the identification of the most important MC characteristics for the service sector.

A ranking was used for each case study, and this ranking could be later compared with the reverse QFD results. In the first case study, the most remarkably important characteristics were C2, C3, C5 and C10 and the least important ones were C1, C4 and C6. Nevertheless, for the second case study, the most important characteristics were C3 and C4, while the least important ones were C11 and C9. The firm's opinion shows that it is

Mass customization characteristics		Importance for the respondent	
		Case 1	Case 2
C1	The structure/architecture of services organized into families, platforms, modules and components	5.00	5.00
C2	Adaptable designs obtained from customized processes	10.00	7.00
C3	Integration of customers into the service process, allowing total fulfillment of their needs and expectations	10.00	8.00
C4	Marketing planning and service marketing	3.00	8.00
C5	Information systems that work as communications channels	10.00	7.00
C6	Supply chain customization	6.00	5.00
C7	Data management, configurations and service delivery stages	9.00	5.00
C8	Determination of costs per activities	7.00	4.00
C9	Integration between service planning and the goals of the organization	8.00	5.00
C10	Agile and quick service delivery	10.00	5.00
C11	Tools (concurrent engineering, hybrid systems, etc.) and production strategies (lean production, mass production, etc.)	7.00	2.00
C12	Knowledge creation through information feedback	8.00	5.00
C13	Reproducibility, standardization, prototyping and individualization techniques	9.00	7.00

Table IV. Information collected from the firms

not possible to make a preliminary analysis of the importance of service customization characteristics, because it is very different in each case study. In fact, this analysis justifies the need for a systematic approach to service customization.

Discussion

The case studies showed how the method used can help with the planning of mass-customized services. In the first case study, in addition to the weights of importance given to MC characteristics, the firm also informed variability and inseparability as the most important dimensions.

Using this definition, it was possible to weight the reversal criteria. The reversal revealed change of position in most characteristics, and the results are shown in Table V. As a matter of fact, the order of the characteristics determined by the reverse QFD is not important, but what does matter is to what extent these characteristics vary as to the initial position defined by the firm. Therefore, Table V also shows the classification initially used by the firm, allowing for the analysis of how much the characteristics vary.

Characteristics C2 and C5 were regarded by the firm as the most important ones. However, characteristics C3 and C10 were at the same level, but in the final classification, they rank in the tenth and seventh positions, respectively. This shows that the initial judgment of the organization was not so appropriate given the service

Reverse QFD		Company grade		Characteristics
−634.55	C4	3.00	C4	Marketing planning and service marketing
−262.02	C8	5.00	C1	The structure/architecture of services organized into families, platforms, modules and components
−225.31	C6	6.00	C6	Supply chain customization
−73.182	C3	7.00	C8	Determination of costs per activities
−61.028	C7	7.00	C11	Tools (concurrent engineering, hybrid systems, etc.) and production strategies (lean production, mass production, etc.)
−49.338	C13	8.00	C9	Integration between service planning and the goals of the organization
2.18103	C10	8.00	C12	Knowledge creation through information feedback
47.6998	C9	9.00	C7	Data management, configurations and service delivery stages
60.7123	C1	9.00	C13	Reproducibility, standardization, prototyping and individualization techniques
64.7277	C2	10.00	C2	Adaptable designs obtained from customized processes
83.5653	C12	10.00	C3	Integration of customers into the service process, allowing total fulfillment of their needs and expectations
166.838	C5	10.00	C5	Information systems that work as communications channels
401.824	C11	10.00	C10	Agile and quick service delivery

Notes: reduction; increase; same ranking

Table V.
Ranking for case Study 1

dimensions prioritized by the organization. This makes sense in this case, as C3 refers to the total fulfillment of customer needs, which has to do more with an individualization strategy than with an MC one; C10, on the other hand, is related to how the firm manages demand, relying more on the sequencing capacity to meet customer's needs than on the people involved in service delivery.

Characteristics C4 and C6, initially considered by the firm to be the least important ones, were confirmed to be so after application of the method. Nevertheless, C1, which was not important in the firm's opinion, went up to the fifth position. In fact, this growth can be explained by the importance that experts ascribed to this characteristic, and even if the firm does not see the clear importance of product structure, expert opinion will prevail. In addition, as the firm regards inseparability as one of the major criteria, this necessarily implies organization of product structure so that this service dimension is contemplated.

Another characteristic that is noteworthy is C12. Initially ranked in sixth position by the firm, this characteristic went up to the third position. This growth can be attributed to the grade given based on expert opinion, given that customization information can be used as learning tools as far as customer demand is concerned, something that is not easily perceived by an organization.

For the second case, Table VI provides the information in a similar way to that of the first case. In this case, intangibility was the most important service dimension according to the university. The inversion of characteristics after the reverse QFD is highly perceptible. The four characteristics deemed to be the most important by the organization are different after the application of the method. Characteristics C7, C9, C11 and C12 take the first positions. Characteristic C11 is preponderant especially because of the importance given by experts, as, in the case of this university, using production tools and strategies is apparently less urgent than other changes. For instance, characteristic C9 is very important for the organization and was not well-ranked initially. As a matter of fact, for such an organization to plan a customized service, one of the priorities is to assess how to break this down in terms of organizational goals; therefore, it is no use thinking up a customized service if the firm is designed to a different type of goal.

The third position is occupied by characteristic C12. In this case, the reverse QFD also played a role in its reclassification. Initially not addressed as a priority, the creation of knowledge through feedback is important for short-duration programs. The use of information provided by consumers helps define new demands, allowing for larger customization and broader coverage. C7 was another characteristic whose ranking improved. Actually, the university was expected to prioritize the management of its options and steps in the design process and later in the offering of the program. Thus, it is perfectly understandable that C7 has risen in ranking.

On the other hand, it is interesting to observe how C3, C4, C5 and C13 were ranked down. In the case of C3, down-ranking resulted from experts' classification. This characteristic shows a high level of customization to be offered by the firm, so even if the organization considers it to be important, it cannot prioritize this characteristic to the detriment of others. Characteristic C4 totally inverted its position in the ranking. This occurred because this characteristic depends on the strategy adopted by the organization and also because it is not regarded by experts as something different in MC.

Reverse QFD		Company grade		Characteristics
−15.876	C4	2.00	C11	Tools (concurrent engineering, hybrid systems, etc.) and production strategies (lean production, mass production, etc.)
−14.92	C8	4.00	C8	Determination of costs per activities
−14.148	C10	5.00	C1	The structure/architecture of services organized into families, platforms, modules and components
−8.7921	C13	5.00	C6	Supply chain customization
−7.3463	C5	5.00	C7	Data management, configurations and service delivery stages
−6.8225	C6	5.00	C9	Integration between service planning and the goals of the organization
−2.2643	C2	5.00	C10	Agile and quick service delivery
3.4107	C1	5.00	C12	Knowledge creation through information feedback
7.31674	C3	7.00	C2	Adaptable designs obtained from customized processes
11.0238	C7	7.00	C5	Information systems that work as communications channels
16.3495	C12	7.00	C13	Reproducibility, standardization, prototyping and individualization techniques
22.3569	C9	8.00	C3	Integration of customers into the service process, allowing total fulfillment of their needs and expectations
54.2883	C11	8.00	C4	Marketing planning and service marketing

Notes: ■ reduction; □ increase; ▒ same ranking

Table VI.
Ranking for case Study 2

Characteristic C5 fell in ranking, as expert opinion is seen as an interface between the customer and the organization. The classification by the firm results from the interpretation that this characteristic serves as the channel for selling the product. This way, it is possible to understand why this characteristic is lowered from its initial ranking. Finally, one can explain the down-ranking of characteristic C13 by the importance given by experts to standardization and individualization. Actually, standardization and individualization depend on a customization structure, and this characteristic is important to turn MC of services into a mature strategy.

In fact, there are customization characteristics that are more compatible with services, while some others are incompatible, as shown in Table VII. For example, C11 and C12 are closer to the service sector, whereas C4 and C8 are farther from it.

Interestingly, cases are not supposed to prove or show which customization characteristic is closer to the service sector; therefore, Table VII is used to guide the discussions. It is important to highlight that the method used allows including an initial stage in the planning of mass-customized services, something that had not been ever addressed in the literature. Studies demonstrate how to maintain a customized service or what can be done to improve this service, while the present study helps devise customized services.

Mass customization characteristics		Importance for implementation of customized services Case 1	Case 2
C1	The structure/architecture of services organized into families, platforms, modules and components	5th	6th
C2	Adaptable designs obtained from customized processes	4th	7th
C3	Integration of customers into the service process, allowing total fulfillment of their needs and expectations	10th	5th
C4	Marketing planning and service marketing	13th	13th
C5	Information systems that work as communications channels	2nd	9th
C6	Supply chain customization	11th	8th
C7	Data management, configurations and service delivery stages	9th	4th
C8	Determination of costs per activities	12th	12th
C9	Integration between service planning and the goals of the organization	6th	2nd
C10	Agile and quick service delivery	7th	11th
C11	Tools (concurrent engineering, hybrid systems, etc.) and production strategies (lean production, mass production, etc.)	1st	1st
C12	Knowledge creation through information feedback	3rd	3rd
C13	Reproducibility, standardization, prototyping and individualization techniques	8th	10th

Table VII. Comparison of rankings

Practical and managerial implications

Cases used to test method steps are from different service areas. The first case was conducted with electric power supplier and the second case was conducted at university. The comparison presented in Table VII shows a big difference between what can be implemented and what is considered important by the organizations. The implementation can occur in its entirety to the characteristics C1, C4, C5, C7, C10, C11 and C12. It shows that despite easy customization, organization is not always interest in service features customization. The explanation in these two cases is customization cost, which compared to the benefit does not seem advantageous for the organization.

Features proposed in literature as low-level customizable were highlighted (general) as important by companies. It is not a problem for the methodology, because customization in a low level does not reduce the importance of customization, but it confirms that service should offer flexibility.

Another thing to note was that characteristics C6 and C9, which were assumed as low importance for customized services implementation, were evaluated without major differences from others. Moreover, new studies should be performed to prove how many important these elements are at model proposed.

Conclusions

New studies have been developed on customized services. Apparently, the use of manufacture characteristics in customization environments could be strange and not easily adapted. Therefore, this study proposes a system for the design of mass-customized services. To do that, expert opinions were used, as well as case studies on organization of services and use of a QFD/reverse QFD procedure to add an initial

stage to plan the design of mass-customized services. However, there are some shortcomings associated with this method.

First, service customization should be independent of essential or peripheral attributes of the service. Actually, when a service is a project, it is necessary to identify what is central to this service and what entails it. In this respect, customization must be focused on the central part of what is offered rather than on peripheral elements. The method reveals that the design of customized services cannot include all the elements related to the service, but it should focus on what is essential. If this focus is lost, one does not know which characteristics should be prioritized, as observed in the cases used to exemplify the use of the method.

It may also be said that the cases used are not definitive for the validation of the proposed method. The study contributes to creating a method for designing customized services. Other case studies are necessary to show how mass-customized services can be characterized, improving the conclusions drawn from the cases.

The grade given by experts should also be improved. For reproducibility of the cases, it would be interesting to collect other opinions and add them to the set of means used in this paper. New opinions could corroborate the information collected in this study or contrast it. In both cases, these new opinions are interesting, as they can confirm the cases or add some regional characteristics to the place where the service is being customized.

Finally, we may say that the method can be used to design customized services. There is a theoretical background that supports the MC characteristics and enablers and the service enablers. In addition, a similar system for the design of customized services has not been described in the literature.

References

Abdelkafi, N., Pero, M., Blecker, T. and Sianesi, A. (2010), "NPD-SCM alignment in mass customization", in Fogliatto, F.S. and Da Silveira, G. (Eds), *Mass Customization: Engineering and Managing Global Operations*, Springer-Verlag, London.

Akao, Y. (1996), *Manual de aplicação do desdobramento da função qualidade, Introdução ao desdobramento da qualidade*, UFMG, Escola de Engenharia, Fundação Cristiano Ottoni, trad. de Zelinda Tomie Fujikawa, Seiichiro Takahashi, Belo Horizonte, Vol. 1.

Alizon, F., Khadke, K., Thevenot, H.J., Gershenson, J.K., Marion, T.J., Shooter, S.B. and Simpson, T.W. (2007), "Framework for product family design and development", *Concurrent Engineering: Research and Applications*, Vol. 15 No. 2, pp. 187-199.

Apeagyei, P.R. and Otieno, R. (2007), "Usability of pattern customizing technology in the achievement and testing of fit for mass customisation", *Journal of Fashion Marketing and Management*, Vol. 11 No. 3, pp. 349-365.

Bare, M. and Cox, J.J. (2008), "Applying principles of mass customization to improve the empirical product development process", *Journal of Intelligent Manufacturing*, Vol. 19 No. 5, pp. 565-576.

Bardakci, A. and Whitelock, J. (2003), "Mass-customisation in marketing: the consumer perspective", *Journal of Consumer Marketing*, Vol. 20 No. 5, pp. 463-479.

Bardakci, A. and Whitelock, J. (2004), "How 'ready' are customers for mass customization? An exploratory investigation", *European Journal of Marketing*, Vol. 38 Nos 11/12, pp. 1396-1416.

Bardakci, A. and Whitelock, J. (2005), "A comparison of customers' readiness for mass-customisation: Turkish vs British customers", *European Business Review*, Vol. 17 No. 5, pp. 397-410.

Bask, A.H., Tinnila, M. and Rajahonka, M. (2010), "Matching service strategies, business models and modular business processes", *Business Process Management Journal*, Vol. 16 No. 1, p. 153-180.

Booms, B.H. and Bitner, M.J. (1981), "Marketing strategies and organizational structures for service firms", in Donnelly, J. and George, W.R. (Eds), *Marketing of Services*, American Marketing Association, Chicago, IL, pp. 47-51.

Brown, S. and Bessant, J. (2003), "The manufacturing strategy-capabilities links in mass customisation and agile manufacturing – an exploratory study", *International Journal of Operations & Production Management*, Vol. 23 No. 7, pp. 707-730.

Buffington, J. (2011), "Comparison of mass customization and generative customization in mass markets", *Industrial Management & Data Systems*, Vol. 111 No. 1, pp. 41-62.

Cao, J., Wang, J., Law, K., Zhang, S. and Li, M. (2006), "An interactive service customization model", *Information and Software Technology*, Vol. 48 No. 4, pp. 280-296.

Chen, Z. and Wang, L. (2007), "A generic activity-dictionary based method for product costing in mass customization", *Journal of Manufacturing Technology Management*, Vol. 18 No. 6, pp. 678-700.

Cho, H. and Fiorito, S.S. (2009), "Acceptance of online customization for apparel shopping", *International Journal of Retail & Distribution Management*, Vol. 37 No. 5, pp. 389-407.

Connell, L.J.A., Ulrich, P.V. and Brannon, E.L. (2002), "A consumer-driven model for mass customization in the apparel market", *Journal of Fashion Marketing Management*, Vol. 6 No. 3, pp. 240-258.

Corbett, B. and Rosen, D.W. (2004), "A configuration design based method for platform commonization for product families", *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, Vol. 18 No. 1, pp. 21-39.

Dahmus, J.B., Zugasti, J.G.P. and Otto, K.N. (2001), "Modular product architecture", *Designs Studies*, Vol. 22 No. 5, pp. 409-424.

Dai, Z. and Scott, M.J. (2007), "Product platform design through sensitivity analysis and cluster analysis", *International Journal of Intelligent Manufacturing*, Vol. 18 No. 1, pp. 97-113.

Davis, S.M. (1987), "From future perfect: mass customizing", *Planning Review*, Vol. 17 No. 2, pp. 16-21.

Da Silveira, G., Borenstein, D. and Fogliatto, F.S. (2001), "Mass customization: literature review and research directions", *International Journal of Production Economics*, Vol. 72 No. 1, pp. 1-13.

Dean, P.R., Tu, Y.L. and Xue, D. (2009), "An information system for one-of-a-kind production", *International Journal of Production Research*, Vol. 47 No. 4, pp. 1071-1087.

Dietrich, A.J., Kirn, S. and Sugumaram, V. (2007), "A service-oriented architecture for mass customization: a shoe industry case study", *IEEE Transactions on Engineering Management*, Vol. 54 No. 1, pp. 190-204.

Du, J., Jiao, Y. and Jiao, J. (2005), "Integrated BOM and routing generator for variety synchronization in assembly-to-order production", *Journal of Manufacturing Technology Management*, Vol. 16 No. 2, pp. 233-243.

Duray, R. (2002), "Mass customization origins: mass or custom manufacturing?", *International Journal of Operations & Production Management*, Vol. 22 No. 3, pp. 314-328.

Duray, R., Ward, P.T., Milligan, G.W. and Berry, W.L. (2000), "Approaches to mass customization: configurations and empirical validation", *Journal of Operations Management*, Vol. 18 No. 6, pp. 605-625.

Endo, S. and Kincade, D.H. (2008), "Mass customization for long-term relationship development: why consumers purchase mass customized products again", *Qualitative Market Research: An International Journal*, Vol. 11 No. 3, pp. 275-294.

Feng, Y.X., Zheng, B., Wei, Z. and Tan, J.R. (2008), "An exploratory study of the general requirement representation model for product configuration in mass customization mode", *International Journal of Advanced Manufacturing Technology*, Vol. 40 Nos 7/8, pp. 785-796.

Fitzsimmons, J.A. and Fitzsimmons, M.J. (2010), *Administração de Serviços*, Bookman, Porto Alegre.

Fixson, S.K. (2007), "Modularity and commonality research: past developments and future opportunities", *Concurrent Engineering: Research and Applications*, Vol. 15 No. 2, pp. 85-110.

Fogliatto, F.S. and da Silveira, G.J.C. (2008), "Mass customization: a method for market segmentation and choice menu design", *International Journal of Productions Economics*, Vol. 111 No. 2, pp. 606-622.

Fogliatto, F.S., da Silveira, G.J.C. and Borenstein, D. (2012), "The mass customization decade: an updated review of the literature", *International Journal of Production Economics*, Vol. 138 No. 1, pp. 14-25.

Gershenson, J.K. (2004), "Product modularity: measures and design methods", *Journal of Engineering Design*, Vol. 15 No. 1, pp. 33-51.

Gershenson, J.K., Prasad, G.J. and Zhang, Y. (2003), "Product modularity: definitions and benefits", *Journal of Engineering Design*, Vol. 14 No. 3, pp. 295-313.

Gottfridsson, P. (2010), "Development of personalized services in small business: an iterative learning process", *Managing Service Quality*, Vol. 20 No. 4, pp. 388-400.

Grenci, R.T. and Watts, C.A. (2007), "Maximizing customer value via mass customized e-consumer services", *Business Horizons*, Vol. 50 No. 2, pp. 123-132.

Haug, A., Ladeby, K. and Edwards, K. (2009), "From engineer-to-order to mass customization", *Management Research News*, Vol. 32 No. 7, pp. 633-644.

Helo, P.T., Xu, Q.L., Kyllönem, S.J. and Jiao, R.J. (2010), "Integrated vehicle configuration system – connecting the domains of mass customization", *Computer in Industry*, Vol. 61 No. 1, pp. 44-52.

Helms, M.M., Ahmadi, M., Jih, W.J.K. and Ettkin, L.P. (2008), "Technologies in support of mass customization strategy: exploring the linkages between e-commerce and knowledge management", *Computers in Industry*, Vol. 59 No. 4, pp. 351-363.

Hoek, R.I.V. (2001), "The rediscovery of postponement a literature review and directions for research", *Journal of Operations Management*, Vol. 19, pp. 161-184.

Huang, G.Q., Zhang, X.Y. and Liang, L. (2005), "Towards integrated optimal configuration of platform products, manufacturing processes, and supply chains", *Journal of Operations Management*, Vol. 23, pp. 267-290.

Huang, G.Q., Zhang, X.Y. and Lo, V.H.Y. (2007), "Integrated configuration of platform products and supply chains for mass customization: a game-theoretic approach", *IEEE Transactions on Engineering Management*, Vol. 54 No. 1, pp. 156-171.

Ismail, H., Reid, I., Poolton, J., Arokiam, I. and Mooney, J. (2007), "How small and medium enterprises effectively participate in the mass customization game", *IEEE Transactions on Engineering Management*, Vol. 54 No. 1, pp. 88-97.

Jiao, J., Ma, Q. and Tseng, M.M. (2003), "Towards high value-added products and services: mass customization and beyond", *Technovation*, Vol. 23 No. 10, pp. 809-821.

Jiao, J., Simpson, T.W. and Siddique, Z. (2007), "Product family design and platform-based product development: a state-of-the-art review", *Journal of Intelligent Manufacturing*, Vol. 18 No. 1, pp. 5-29.

Jiao, J. and Tseng, M.M. (1999), "A methodology of developing product family architecture for mass customization", *Journal of Intelligent Manufacturing*, Vol. 10 No. 1, pp. 3-20.

Jiao, J. and Tseng, M.M. (2004), "Customizability analysis in design for mass customization", *Computer Aided Design*, Vol. 36, pp. 745-757.

Jin, L., He, Y. and Song, H. (2012), "Service customization: to upgrade or to downgrade? An investigation of how option framing affects tourists' choice of package-tour services", *Tourism Management*, Vol. 33 No. 2, pp. 266-275.

Jitpaiboon, T., Dangol, R. and Walters, J. (2009), "The study of cooperative relationships and mass customization", *Management Research News*, Vol. 32 No. 9, pp. 804-815.

Jose, A. and Tollenaere, M. (2005), "Modular and platform methods for product family design: literature analysis", *Journal of Intelligent Manufacturing*, Vol. 16, pp.371-390.

Karlsson, A. (2002), "Assembly-initiated production – a strategy for mass-customization utilizing modular, hybrid automatic production systems", *Assembly Automation*, Vol. 22 No. 3, pp. 239-247.

Kincade, D.H., Regan, C. and Gibson, F.Y. (2007), "Concurrent engineering for product development in mass customization for the apparel industry", *International Journal of Operations & Production Management*, Vol. 27 No. 6, pp. 627-649.

Kotha, S. (1995), "Mass customization: implementing the emerging paradigm for competitive advantage", *Strategic Management Journal*, Vol. 16, pp. 21-42.

Kotler, P. and Keller, K.L.(2006), *Administração de Marketing*, Pearson, São Paulo.

Kumar, A. (2008), "From mass customization to mass personalization: a strategic transformation", *International Journal of Flexibility and Manufacturing System*, Vol. 19, pp. 533-547.

Kumar, A., Gatoufi, S. and Reisman, A. (2008), "Mass customization research: trends, directions, diffusion intensity, and taxonomic frameworks", *International Journal of Flexibility and Manufacturing System*, Vol. 19 No. 4, pp. 637-665.

Lee, N.K.S. and Dai, J.B. (2010), "Designing and planning of material handling systems for mass customization", in Fogliatto, F.S. and Da Silveira, G. (Eds), *Mass Customization: Engineering and Managing Global Operations*, Springer-Verlag, London.

Levitt, T. (1991), *A Imaginação de Marketing*, Atlas, São Paulo, 1991.

Li, Y., Xue, D. and Gu, P. (2008), "Design for product adaptability", *Concurrent Engineering*, Vol. 16 No. 3, pp. 221-232.

Lindquist, A., Berglund, F. and Johannesson, H. (2008), "Supplier integration and communication strategies in collaborative platform development", *Concurrent Engineering*, Vol. 16 No. 1, pp. 23-35.

Liou, J.J.H., Yen, L. and Tzeng, G.H. (2010), "Using decision rules to achieve mass customization of airline services", *European Journal of Operations Research*, Vol. 205, pp. 680-686.

Lovelock, C., Wirtz, J. and Hemzo, M. (2011), *Marketing de Serviços: Pessoas, Tecnologia e Estratégias*, Pearson, São Paulo.

Ma, Y., Jiao, J. and Deng, Y. (2008), "Web service-oriented electronic catalogs for product customization", *Concurrent Engineering*, Vol. 16 No. 4, pp. 263-270.

Marion, T.J., Freyer, M., Simpson, T.W. and Wysk, R.A. (2006), "Design for mass customization in the early stages of product development", *International Design Engineering Technical Conferences & Computers and Information in Engineering Conference*, pp. 10-13.

McCarthy, I.P., Pitt, L. and Berthon, P. (2010), "Service customization through dramaturgy", in Fogliatto, F.S. and Da Silveira, G. (Eds), *Mass Customization: Engineering and Managing Global Operations*, Springer-Verlag, London.

Muffatto, M. (1999), "Introducing a platform strategy in product development", *International Journal of Production Economics*, Vols 60/61 No. 1, pp. 145-153.

Mun, D., Jang, K., Han, S., Kim, J. and Hwang, H. (2007), "Engineered-to-order approach for providing flexibility in e-commerce of mold parts", *Concurrent Engineering*, Vol. 15 No. 4, pp. 345-355.

Ni, Q.F., Lu, W.F. and Yarlagadda, P.K.D.V. (2008), "An extensible product structure model for product lifecycle management in the make-to-order environment", *Concurrent Engineering*, Vol. 16 No. 4, pp. 243-251.

Nielsen, K.J. and Cox, J.J. (2008), "Implementation of biomechanical mating conditions in CAD", *Computer Aided Design and Applications*, Vol. 5 Nos 1/2/3/4, pp. 338-353.

O'Shaughnessy, J. and O'Shaughnessy, N.J. (2009), "The service-dominant perspective: a backward step?", *European Journal of Marketing*, Vol. 43 Nos 5/6, pp. 784-793.

Pan, B. and Holland, R. (2006), "A mass customised supply chain for the fashion system at the design-production interface", *Journal of Fashion Marketing and Management*, Vol. 10 No. 3, pp. 345-359.

Peters, L. and Saidin, H. (2000), "IT and the mass customization of services: the challenge of implementation", *International Journal of Information Management*, Vol. 20 No. 2, pp. 103-119.

Piller, F.T. (2004), "Mass customization: reflections on the state of the concept", *International Journal of Flexible Manufacturing Systems*, Vol. 16 No. 4, pp. 313-334.

Piller, F.T. (2008), "Observations on the present and future of mass customization", *International Journal of Flexibility and Manufacturing System*, Vol. 19 No. 4, pp. 630-636.

Piller, F.T., Moeslein, K. and Stotko, C.M. (2004), "Does mass customization pay? An economic approach to evaluate customer integration", *Production Planning and Control*, Vol. 15 No. 4, pp. 435-444.

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

Salvador, F., Martin, P. and Piller, F. (2009), "Decodificando a customização em massa", *HSM Management*, Vol. 6 No. 77, pp. 140-148.

Shamsuzzoha, A., Kyllönen, S. and Helo, P. (2009), "Collaborative customized product development framework", *Industrial Management and Data System*, Vol. 109 No. 5, pp. 718-735.

Siddique, Z. and Boddu, K.R. (2004), "A mass customization information framework for integration of customer in the configuration/design of a customized product", *Artificial*

Intelligence for Engineering Design, Analysis and Manufacturing, Vol. 18 No. 1, pp. 71-85.

Sigala, M. (2006), "Mass customization implementation models and customer value in mobile phones services: preliminary findings from Greece", *Managing Service Quality*, Vol. 16 No. 4, pp. 395-420.

Silveira, G., Borenstein, D. and Fogliatto, F.S. (2001), "Mass customization: literature review and research directions", *International Journal of Production Economics*, Vol. 72 No. 1, pp. 1-13.

Simpson, T.W. (2004), "Product platform design and customization: status and promise", *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, Vol. 18 No. 1, pp. 3-20.

Simpson, T.W., Maier, J.R.A. and Mistree, F. (2001), "Product platform design: method and application", *Research Engineering Design*, Vol. 13 No. 1, pp. 2-22.

Simpson, T.W., Marion, T., Weck, O., Otto, K.H., Kokkolaras, M. and Shooter, S.B. (2006), "Platform-based design and development: current trends and needs in industry", *International Design Engineering Technical Conferences & Computers and Information in Engineering Conference*.

Spring, M. and Araujo, L. (2009), "Services, services and products: rethinking operations strategy", *International Journal of Operations & Production Management*, Vol. 29 No. 5, pp. 444-467.

Starr, M.K. (2010), "Modular production – a 45-year-old concept", *International Journal of Operations & Production Management*, Vol. 30 No. 1, pp. 7-19.

Tang, A., Avgeriou, P., Jansen, A., Capilla, R. and Babar, M.A. (2010), "A comparative study of architecture knowledge management tools", *The Journal of Systems and Software*, Vol. 83 No. 3, pp. 352-370.

Thevenot, H.J. and Simpson, T.W. (2006), "Commonality indices for product family design: a detailed comparison", *Journal of Engineering Design*, Vol. 17 No. 2, pp. 99-119.

Tseng, M.M. and Jiao, J. (1996), "Design for mass customization", *Annals of the CIRP*, Vol. 45 No. 1, pp. 153-156.

Tseng, M.M. and Radke, A.M. (2010), "Production planning and control for mass customization", in Fogliatto, F.S. and Da Silveira, G. (Eds), *Mass Customization: Engineering and Managing Global Operations*, Springer-Verlag, London.

Wang, H. and Lin, Z. (2008), "Defects tracking matrix for mass customization production based on house of quality", *International Journal of Flexibility and Manufacturing System*, Vol. 19, pp. 666-684.

Williams, C.B., Allen, J.K., Rosen, D.W. and Mistree, F. (2007), "Designing platforms for customizable products and processes in markets of non-uniform demand", *Concurrent Engineering*, Vol. 15 No. 2, pp. 201-216.

Yang, B., Burns, N.D. and Backhouse, C.J. (2004), "Postponement: a review and an integrated framework", *International Journal of Operations & Production Management*, Vol. 24 No. 5, pp. 468-487.

Zha, X.F., Sriram, R.D. and Lu, W.F. (2004), "Evaluation and selection in product design for mass customization: a knowledge decision support approach", *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, Vol. 18 No. 1, pp. 87-109.

Zahaj, D. and Griffin, A. (2002), "Are customer information systems worth it? Results from B2B services", Working Paper, Marketing Science Institute, Champaign, IL.

Zhang, W.Y., Tor, S.Y. and Britton, G.A. (2005), "Managing modularity in product family design with functional modeling", *International Journal of Advanced Manufacturing Technology*, Vol. 30, pp. 579-588.

Zhang, X. and Chen, R. (2006), "Forecast-driven or customer-order-driven? An empirical analysis of the Chinese automotive industry", *International Journal of Operations & Production Management*, Vol. 26 No. 6, pp. 668-688.

Zeithaml, V.A. (1981), "How consumer evaluation process differ between goods and services", in Donnelly, J. and George, W.R. (Eds), *Marketing of Services*, American Marketing Association, Chicago, IL, pp. 186-190.

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