Original Article

Mass customization strategy development by FIRM

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ABSTRACT *Purpose* – Nowadays, managers achieve superior performance and greater efficiency by evaluating their firm's readiness for mass customization before committing their company to such a strategy. The purpose of this article is to handle this issue by proposing a managerial framework – named FIRM – for firm profiling, which offers the strategic shift toward mass customization concept. The aim is to provide a tool for executives, which helps them discuss strengths and weaknesses in the internal production and information technology areas before utilizing these policies. *Design/methodology/approach* – The research procedure consists of measurement scales generation, data gathering, purification phase, firm clustering and profiling. Using Delphi method and brainstorming sessions, a questionnaire is developed, pretested and administered for a firm's profiling in today's marketing and production environment. *Findings* – A validation test of FIRM is presented and satisfactory levels of Cronbach's α are obtained at the end of the purification process. The results lead us to believe that the five-dimension structure of FIRM may be reduced to a four-dimension construct. Using *k*-means cluster analysis results, three different groups of firms are founded. We claim that FIRM would help strategic decision-makers to identify the particular policies and configurations necessary for their business. Clear directions on how to manage customization policies for each firm belonging to special cluster is provided. *Originality/value* – Chief organizational leaders in various kinds of industries may employ FIRM as an assessment tool to successfully utilize their knowledge and understanding of the firm and its customers. It will help them to support their customization policies.

INTRODUCTION

Companies face a lot of difficulties to gain a strategic position and to differentiate themselves from other competitors in today's saturated markets, where there exist a high intensity of competitors and low profit margins. Mass customization is a broad approach to deal with these new market challenges, which offers a competitive edge and the opportunity to enhance profit margins. Theoretical and empirical studies have acknowledged the positive opportunities of mass customization for many years, attracting a lot of attention by managers from different kinds of industries within the last decade.[1–4] In fact, mass customization is changing the way consumer products are designed, manufactured, delivered and recycled. Accordingly, Piller *claims* that *The mass customization landscape today reveals a somewhat sobering picture*.[5] Respectively, to understand different aspects of the firm and to profile it precisely, managers should first analyze their business carefully and then commit their company to a mass customization strategy.[6] Firms may use the synergy of knowledge management and e-commerce integration to gather the data of customer preferences and evaluate these data to advance mass customization. E-commerce captures external information, which consists of data on customer feedback and electronic interactions. Knowledge management integrates this information with expertise gained from employees and customers to evolve product and service offerings for customization.[7] Development of information and communication technologies (ICT) and efficient operational systems together help managers customize their products and add value through different customization approaches, ranging from basic product versioning to reverse marketing.[8,9]

The purpose of this article is to introduce and validate a managerial framework – named FIRM[10] – that executives may employ it as an actionable tool for customization management.[11]

Reasons for carrying out this research are as follows: first, although several studies have examined customers' readiness for mass customization, little attention has been given to facilitate this finding from an organizational perspective. Second, until now most articles on the mass customization concept with a strategic theme have not addressed a specific model to handle it. Third, studies concerning this issue have only focused on single variables (for example, manufacturing and supply chain or e-commerce), explaining firm heterogeneity toward mass customization strategies. They did not provide clear directions on how to manage customization policies for each firm belonging to special cluster concerning multiple variables. Moreover, FIRM contributes to the customization research by integrating a set of dimensions in a well-known clustering process aimed at analyzing and managing a wide range of heterogeneous firm objectives. These objectives include both internal and external business aspects, which encompass market needs on the one hand and operational efficiencies on the other. This means that FIRM represents a model based on analytical dimensions and is potentially applicable for various kinds of firms and markets and may help top managers to support their customization policies. Finally, key organizational leaders may use FIRM to discuss strengths and weaknesses in internal production and information technology areas to more easily implement a mass customization strategy. Furthermore, we demonstrate a validation test of FIRM and derive directions for customization management and future research.

In the following sections, we begin with a brief overview of mass customization issues and provide its chronological history. FIRM pillars are then described, as well as its validation methodology. Next, we identify and discuss several potential indicators for each of the dimensions of

FIRM, followed by testing its validity. Then we extract clusters describing firm attributes with regard to their mass customization abilities. Finally, we conclude with managerial implications for utilizing theses strategies and encourage further research to extend our study into different areas of the world and types of companies.

CRITICAL ISSUES IN MASS CUSTOMIZATION

The chronological history of product and service differentiation (here after we will use product instead of product and service) starts with product line stretching and versioning. Product versioning like software industries offers different versions of a product to please the changing needs of customers. Later, mass customization brings a huge variety of product versions by combining a large number of product modules.[1,12] It aims to satisfy heterogeneous customer desires and preferences thanks to flexible operational systems. Mass customization encompasses companies selling their products to personal consumers, as well as selling to other businesses.[6] Customization is a new strategy to deal with changing customer demands, which enables firms to enhance their interaction with customers.[8] In this approach, both interactional and operational aspects must be flexible in order to allow products to be customized. When the interaction of customers with firms is enhanced, another concept called co-creation emerges, which consists of the joint creation of unique value to customers through the means of new ICT infrastructure.[13] The latest customer-driven strategy is reverse marketing for which customers (instead of marketers) are responsible for customization.[14,15] In this strategy, customers have an active role in the process of product designing. Some enabling technologies like computer-aided design (CAD) and computer-assisted manufacturing (CAM) have made mass customization strategies more viable. Depending on the customization strategy that the firm applies, various managerial challenges will be raised. For instance, co-creation or reverse marketing strategies that involve the customer in the product development process demand larger organizational and financial investments. Firms need to offer specialized interfaces (like Web features) and customization options (attributes and benefits) to their customers in order to gain competitive advantage and benefit from mass customization opportunities.[9,16]

Although improvements in technology enable firms to develop mass customization strategies more conveniently, limitations on operational capabilities, production, distribution and delivery made it difficult for them to be applied. Lack of integrated supply channels and standardized business processes, complex bills of materials, routings and pricing difficulties are some examples of the problems a company may face in applying these strategies. In other words, mass customization introduces new demands on firms. These include integrated workflows, improved product development processes, flexible manufacturing planning and control systems, collaborative/team-oriented culture environment, valuable knowledge repositories and seamless supply chain management (SCM). Finally, it is important to consider that larger organizations may be able to afford the risk of making mistakes in developing appropriate customization strategies because of their nature and structure. However, small to medium enterprises (SME's) are typically more vulnerable and hence need a structured low-risk approach.[17]

INTRODUCING THE FIRM FRAMEWORK FOR FIRM PROFILING

In this article, we present an analytical framework for firm profiling, which aims at supporting mass customization decisions.

Specifically, we reviewed the e-commerce, knowledge management and customer support literature to identify a set of generally applicable dimensions for this purpose. These areas have been sparsely covered by the literature. Some studies have focused on a single, analytical dimension explaining firm heterogeneity toward mass customization strategies, thus offering only partial insight (such as Berman[18] and Blecker et al[19]). FIRM integrates multiple dimensions that capture firm attributes and consequently enable managers to profile their organization for mass customization readiness. In fact, the framework is based on profound theoretical bases, derived from previous manufacturing strategy, information systems, consumer behavior and marketing literature. Moreover, several studies have shown that customer support, manufacturing and supply chain, e-commerce, knowledge management and intangible assets explain diversity in firm abilities and their current readiness for mass customization (for example, Hart,[20] Zipkin,[21] Helms et al,[7] Coulter,[22] Bardakci and Whitelock[23]). FIRM is applicable to different markets, as it is based on general dimensions. Our research procedure consists of measurement scales generation, data gathering, purification procedures, firm clustering and profiling. In the remainder of this section, we discuss the relevant literature and introduce the pillars included in our model.

Customer support and preference

It was believed by many dominant researchers in 1990s[1–3,24,25] that mass production is not efficient enough to be considered anymore, as it mostly focuses on satisfying average requirements. Mass production leads to a significant gap between the final product features and what a customer really wants. Mass customization enables customers to offer the product they truly desire by considering a customer-driven mythology, which is in contrast to traditional view that mainly focuses on more customers to be served instead of satisfying most needs of a limited basic customers.[26] As a result, one of the critical factors affecting a firm's ability to employ mass customization strategies is its customer's readiness to accept these mass-customized products. Notably, firms must go beyond analysis of expected product benefits and should broaden the scope of customer information management to include customer data on competence, motivation to interact and willingness to pay extra for customized products. In fact, more opportunity will exist, if the market becomes more competitive and customers become more value seekers. Customer-perceived value and consequently their shopping experience enhance as much as their interactions are tailored to their unique requirements.[16]

Some inconveniences that influence the customer decision process to buy a customized product are as follows: first, the higher prices of mass-customized products in contrast to standardized products, which force customers to pay a premium to get what they want. Second, mass customization disables having a finished product at the time of purchase, making customers wait for delivery. Finally, customers need to invest a reasonable amount of time in the designing process to specify their preferences when ordering a customized product.[1,23,27,28] Hence, we assume that customer preference and support, which affect a customer's readiness for mass customization, represent a significant analytical dimension for firm profiling in a wide range of businesses.

Electronic commerce

The buying and selling of information, products and services via computer networks and distributed media, usually the World Wide Web (WWW), is called electronic commerce. It is a necessary requirement to gather the data, which is useful for supporting mass customization

strategies. Business-to-consumer (B2C), business-to-business (B2B) and internal business interactions via an intranet are some types of e-commerce.[29,30] By using interactive and unified e-commerce configuration systems, customers may find a way to describe what they want to purchase. The personal relationship between customers and firms through the Internet will develop over time.[31,32] With Web-based configuration design systems, engineering changes for ordered products may be handled more easily. They could be integrated with production control and planning systems to coordinate suppliers and cross-organizational production processes, allowing them to be more flexible, efficient and tractable.[33] For B2C interactions, some factors such as the amount of product information that a company provides on their Web site, the amount of product transactions conducted online, online search capability for the customer's information inquiry, the online customer service offered and the ability to promote products and service online need to be measured. Some indicators in regard to B2B interactions are as follows:

- The extent of Internet usage in gathering information from customers;
- the extent of Internet usage, to link to suppliers, distributors and other internal and/or external chain partners;
- the level of computer technology for mass customization;
- ability to make communications, collaborations and transactions on WWW and/or EDI.

For internal business interactions through an intranet, it is important to consider how much the firm attempts to integrate workflows using intranet technologies, how much it attempts to provide networking capabilities for employees to communicate with one another and finally the amount of knowledge sharing being encouraged among employees using computer network.[7]

To summarize, substantial evidence suggests that e-commerce and Web infrastructure abilities of a firm should concern all kinds of internal and external business interactions. Therefore, we define electronic commerce as a basis of supporting mass customization decisions and consider it the second relevant dimension for profiling firms.

Knowledge management

It is a business optimization strategy that acquires, creates, reveals and delivers information essential to the business, which allows an enterprise to accomplish its goals and find valuable knowledge for mass customization. Knowledge management considers intellectual capital as a manageable resource associated with design, production and the delivery of innovative products. Therefore, it is an important element to gain a sustainable competitive advantage.[34,35] Knowledge has strategic value but there are few companies that understand the art of managing it perfectly.[36] Capability to manage knowledge repositories of the firm is considered as one of the important factors affecting organizational readiness. The role of knowledge management ranges from supporting customer relationship management (CRM) to configuring custom-made products.[37]

We investigate this dimension via three different areas of interest: knowledge management strategies, objectives and critical success factors. Creating electronic databases and valuable knowledge repositories strengthen innovation, uncover knowledge owned by employees, develop a relevant business strategy, achieve operational improvements to reduce cycle time and costs, improve customer relationship and so on and are some instances of knowledge management objectives. Managers need to pay attention to these objectives in order to be ready for mass customization.

For successful knowledge management implementation, a company's initiatives must be aligned with overall business strategy and viewed as a long-term organizational effort rather than just a short term and one time endeavor. Inter-departmental knowledge management team must be flexible to promote knowledge management efforts. In addition, button-up, system-driven knowledge management strategies should be regarded, as well as top-down ones.[7] On these bases, we define knowledge management as a dimension resulting from innovation-minded and button-up, team-oriented firm structure. We argue that decisions on mass customization policies should consider knowledge management capabilities to admit the extreme forms of customization.

Manufacturing and supply chain

Elicitation, process flexibility and logistics are three important elements in assessing a firms' readiness to implement a mass customization strategy with success.[21] These elements are related to manufacturing, distribution and order management. Elicitation is a mechanism to obtain information about specific needs of customers through interaction with them. The Internet facilitates this mechanism by providing convenient, effective communication infrastructure without any time and distance limitations. Assistance of well-trained service representatives, who have the ability to communicate with customers closely, is one of the greatest requirements of this mechanism. In addition, firms should have the ability to offer a menu of attributes, features, prices and delivery options via the process of product design to help customers choose what they want and then integrate their choices with systems of procurement, assembly and delivery. Developments in design technologies, such as CAM/CAD, virtual reality and multimedia, aid the choice process by enabling consumers to

see their last purchase and alternative product designs. The second significant element of a mass customization internal system is the use of flexible production process and manufacturing systems. It aims at giving every customer individually customized products at a price similar to those of mass-produced products. Firms may reduce production costs and inventory levels through the use of common modular components. Postponement of product differentiation, which adds customized parts to the modular components on the basis of a customer's unique order, likewise lowers the costs and risk of holding finished products inventories.[38] Well-integrated logistics information systems, highly coordinated supply chain links, just–in–time (JIT) inventory systems and virtual integration among channel members are other components that firms need to handle for logistic purpose.[18,39]

Classifying firms relative to their manufacturing and supply chain readiness is therefore crucial. Hence, we presume this pillar as an important dimension for firm profiling.

Intangible assets

For successful e-commerce business, firms need to pay attention to intangible assets such as customer trust, brand image, culture, reliability, incentive capabilities, satisfaction and commitment in the same way as tangible resources like distribution channels, technology and warehousing facilities. Intangible assets of an organization are those assets that cannot be seen, touched or physically measured, and are created through time and effort. This pillar is evaluated through three indicators named 'personality-related', 'performance-related' and culture. In the rest of this section, more explanation of these elements is provided. Empathy, which means warm and caring attitude of service representative toward customers; politeness, which refers to considerate, kind and courteous

behavior of the service agent; and finally, similarity between what a customer perceives and her/his special tastes, values and belief are three important concepts that affect ongoing viability of a service relationship and trust formation. These elements are called 'personality-related' service representative characteristics.[22] Moreover, competence, reliability and promptness, and customization abilities of service representative characterise the firm's performance capabilities. Competence is defined as sufficient skills and knowledge of the service agent to supply the basic service products. Reliability and promptness means the ability to deliver the product in a definite and timely manner. Finally, the customization ability is defined as offering different product attributes to suit the individual customer's demands. The culture environment of a company is another significant criterion. The culture of a company may be highly collaborative and team oriented, or may be hierarchical in structure and reward only individual accomplishments.

In conclusion, substantial grounds lead us to consider intangible assets as the last relevant dimension for firm profiling. Therefore, we define intangible assets as the personality and performance-related service representative characteristic expected by the firm. Consequently, the literature review suggests five dimensions that describe firm heterogeneity toward utilizing mass customization strategies and are applicable to a wide range of markets:

- Customer support and preference, which concerns a customer's readiness to accept mass-customized products.
- Electronic commerce, which concerns the firm's ability to do business transactions (B2B, B2C and internal business interactions) online.
- Knowledge management, which allows an enterprise to accomplish its goals and find valuable knowledge for mass customization.
- Manufacturing and supply chain, which concerns the firm's ability to coordinate its manufacturing, distribution and order management activities.
- Intangible assets, which concerns personality and performance-related service representative characteristic expected by the firm.

Figure 1 describes the entire framework graphically. The feedback mechanisms may support successive managerial decisions
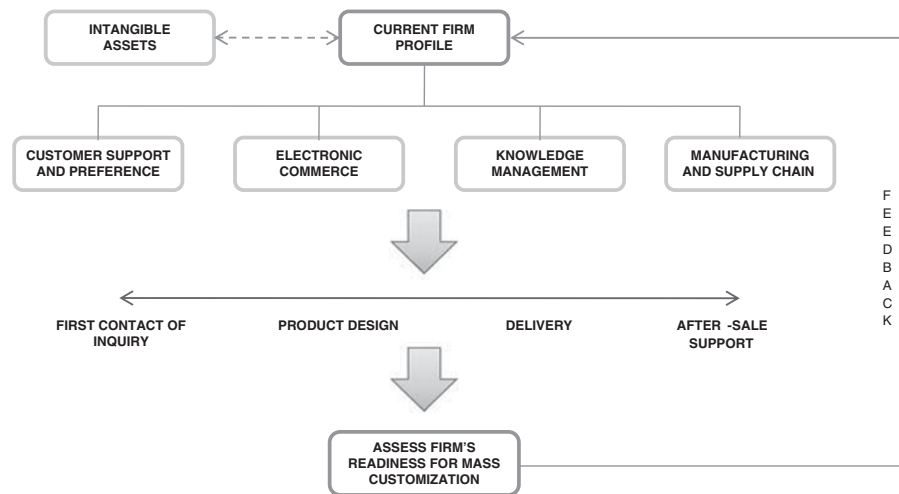

Figure 1: The FIRM framework for firm profiling.

made on the last profile of the firm and its abilities.

In summary, FIRM is based on five analytical dimensions. Previous research suggests that such dimensions discriminate firms across their mass customization readiness, thus being generally applicable in different business contexts. More specifically, these dimensions represent critical facets for identifying the optimal customization policies. We design our research plan based on FIRM in three following steps:

- Identifying a set of indicators for the five dimensions.
- Testing the validity of FIRM.
- Clustering firms based on FIRM.

More detail on each of these three steps is given in the following sections.

IDENTIFYING A SET OF INDICATORS FOR THE FIVE DIMENSIONS

We identified several potential indicators for the five dimensions. In this regard, first we reviewed the operational strategy and mass-customized marketing literature to obtain theoretical directions and find elements that influence each dimension. Then we used Delphi method and conducted brainstorming sessions to find the most impressive indicators (content validity). This method ran in four rounds. The first round of Delphi survey began with the statement 'In order to assess a firm's readiness for mass customization …' followed by four open ended questions. The panels consisted of 25 experts, including scholars who helped us in this research by sharing their ideas and experiences in mass customization through providing questionnaires, surveys, checklists or any results of their ongoing or previous research. In addition, a group of information technology experts in this area among academic professionals,

researchers and professional people were also considered as panel members.

The questions were as follows:

- Is the knowledge infrastructure and strategies of a firm affecting its readiness? How?
- Does the network world, platform of Internet and e-commerce affect the power and readiness of a firm? How?
- What internal/external parameters in the supply chain and manufacturing affect firm's readiness? How?
- What are the other aspects that you think enable a firm to be a good representative of customized products/ services?

Seventeen of the panelists (68 per cent) responded to the survey within the necessary time frame. The facilitator compiled answers into a summary. All 25 panelists were included in successive rounds, regardless of their continued participation. In the second round of Delphi survey, after reviewing the summary of answers of round one, the panel discussed the key variables that were proposed by previous research and scholars.[7] Additional feedbacks and revisions with the group of 18 panelists were conducted. Finally, a questionnaire was developed that measured various aspects of firm's mass customization readiness. In the third round of the Delphi survey, panelists were asked to suggest revisions of the questionnaire. For the fourth round of the Delphi survey, the facilitator sent the panel the revised Likert Scales of assessment measures and five proposed construct groupings and asked them to give their suggestions on it. Finally, the questionnaire was pretested and administered to sale, manufacturing and marketing executives of five companies with different contexts who were not included in the research study previously. Small modifications to some of the questions were made to improve clarity. In conclusion, the panel viewed firm's
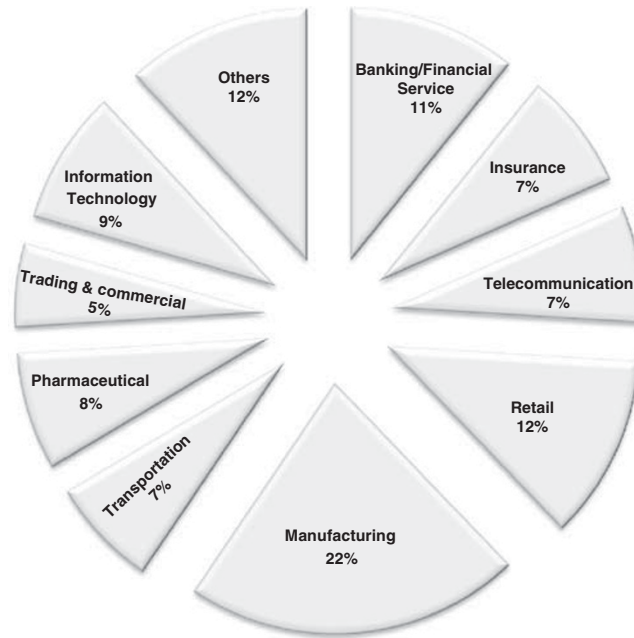
Figure 2: The percentage of different type of firms in sample.

readiness to implement a mass customization strategy as an important topic for the survey questionnaire.

A systematic sampling, which covered different type of firms and industries, was conducted for satisfying the stratification purposes. The industry type represented most often was 'Manufacturing' with 22 per cent (see Figure 2). Furthermore, the respondents were mainly representatives of SME's. More than 350 questionnaires were distributed among firms through regular paper base and e-mail. The data were gathered over the course of 11 months and an adequate response rate was achieved (230 questionnaires). Furthermore, a total of 45 questionnaires were eliminated because of missing responses to the majority of the items, and therefore 185 of the received questionnaires were used for analysis purpose.

Measurement scales purified through separate principal component analysis (PCA)[40] applications to attain their unidimensionality. Indicators with poor levels of factor loadings and variance were gradually dropped. We obtained satisfactory

levels of Cronbach's α at the end of the process (0.8542 over 21 final variables). After the purification process, customer support and preference scale (Cronbach's $\alpha = 0.6969$; variance extracted $= 76.869$ per cent) includes two indicators, measured by 5-point interval scales. They depict mass customization readiness from a consumer demand point of view (customer willingness to buy customized product, customer willingness to pay extra for customized product). In addition, parallel research had been carried out to find more details on indicators affecting customer preference and support dimension.[11] The manufacturing and supply chain scale (Cronbach's $\alpha = 0.9078$; variance extracted $= 71.386$ per cent) encompasses seven indicators describing flexibility of manufacturing activities, the amount of international row material sourcing, the level of possible customization options (measured by either 3-, or 5-point scaled items). Moreover, this scale includes four composite indices describing the importance of manufacturing and supply chain objectives, problems with regard to production and supply chain

channels, adaptive and adequate SCM, average manufacturing cycle time and average delivery time. The electronic commerce scale is measured in terms of network and Internet platforms to do business transactions online. We assume that e-commerce describes different types including B2C, B2B and internal business interactions. This scale (Cronbach's $\alpha = 0.8931$; variance extracted $= 72.865$ per cent) consists of five indicators, describing the extent of Internet usage in gathering information from customers and connecting to chain partners as well as the ability to do B2B, B2C and

intra–organizational transactions on WWW and/or EDI. All indicators were measured by either 3-, or 5-point scaled items. The knowledge management scale (Cronbach's $\alpha = 0.8619$; variance extracted $= 75.846$ per cent) includes four indicators, all measured by 3-, or 5-point interval scales, concerning knowledge management strategies and alignment of knowledge management initiatives with overall business strategy, as well as the flexibility of organizational structure to promote knowledge management efforts. Moreover, the importance of knowledge management objectives measured by a composite index.

Table 1: Indicators related to different dimensions of FIRM

	The influential sources of proposing customized product				
No	*Indicator*		*No*	*Indicator*	
	Description	*Type*		*Description*	*Type*
1	Customer willingness to buy customized product	5-point item	14	Ability to do B2B transactions on WWW and/or EDI	5-point item
2	Customer willingness to pay extra for customized product	5-point item	15	Ability to do online B2C activities and transactions	5-point item
3	**Drivers of mass customization from customer demand point of view**	**3-point item**	16	Ability to do online intra-organizational activities	3-point item
4	The importance of manufacturing and supply chain objectives	Mean of 8 items	17	Knowledge management strategies	5-point item
5	Problems in regard to production and supply chain channels	Mean of 8 items	18	Alignment of knowledge management initiatives with overall business strategy	3-point item
6	Adaptive and adequate supply chain management	Mean of 15 items	**19**	**Knowledge management planning horizon**	**3-point item**
7	Flexibility of manufacturing activities	3-point item	**20**	**Clarity of knowledge definition**	**3-point item**
8	The amount of international row material sourcing	5-point item	21	Flexibility of organizational structure to promote knowledge management efforts	3-point item
9	Average manufacturing cycle time and average delivery time	Mean of 2 items	22	The importance of knowledge management objectives	Mean of 11 items
10	The level of possible customization options	3-point item	23	'Personality-related' characteristics of service representative	Mean of 3 items
11	The extent of Internet usage in gathering information from customers	3-point item	**24**	**The degree of realizing psychographic profile of clients**	**3-point item**
12	The extent of Internet usage for connecting to chain partners	3-point item	25	'Performance-related' characteristics of service representative	Mean of 3 items
13	**The level of computer technology**	**3-point item**	26	The culture environment of company	3-point item

Bold values represent dropped indicators with poor levels of factor loadings and variance.

Finally, the intangible assets scale (Cronbach's $\alpha = 0.9063$; variance extracted $= 86.069$ per cent) comprises three indicators, measured by 3-point scaled items, describing the culture environment of company. Furthermore, 'Personality-related' and 'Performance-related' characteristics of service representative determined with composite indices. At the end of the process, a total of 21 indicators were retained and the rest (5 indicators) were dropped as a result of poor levels of factor loadings and variance. Table 1 demonstrates these indicators, as well as how each one measures.

TESTING THE VALIDITY OF FIRM

PCA was used to assess the reliability and validity of our constructs and identify the number of components to be extracted. It is one of the extraction methods used for factor analysis, which has little deviation from literature recommendations and common practice in marketing applications.[41]

We retained components in two ways; first, components showing eigenvalues larger than 1 were retained. Second, we applied parallel analysis, which compares observed eigenvalues with those resulting from using random data (The formula provided by Lautenschlager et al,[42] and Keeling[43]). Components showing larger observed eigenvalues than those resulting from random data analysis were retained. Both of these two ways suggest extracting four components, three of which nicely correspond to customer support and preference, knowledge management and intangible assets. The findings lead us to believe that two pillars of FIRM, namely manufacturing and supply chain and electronic commerce, belong to one component and not two. We call this new component 'Electronic Supply Chain', as it nicely corresponds with these two pillars. The four-component solution accounts for more than 57 per cent of the variance. All

of the indicators load considerably on the intended dimension, whereas no significant cross loading (that is, > 0.30) was founded. Table 2 shows the factorial structure and purified measurement scales.

In conclusion, the results indicate that the five-dimension structure of FIRM may be reduced to a four-dimension construct. Figure 3 demonstrates our validated final model for firm profiling.

CLUSTERING FIRMS BASED ON FIRM

We used PCA scores as input data and ran a k-means cluster analysis[44] to profile firms relative to their mass customization readiness. Ward's method[45] was applied to derive the correct number of clusters. It is a hierarchical method to define the cluster number on the principal components score. Checking the agglomeration schedule suggested to us three clusters to profile firms. We then utilized three-cluster k-means procedure to actually form the clusters. Table 3 demonstrates final cluster centers and proportions of the three clusters. Note that positive (negative) scores on one specific dimension indicate higher (lower) than average attributes within the clusters.

We label firms belonging to Cluster 1 as *Product innovative* (34.054 per cent). These firms show the highest score on knowledge management and the lowest score on customer support, as well as nearly average electronic supply chain. Web-based internal business interactions through an intranet are highly considered within this cluster and knowledge sharing being encouraged among employees using computer network. The culture environment of these firms is motley employee center and team oriented. The economy of this cluster is based on innovation and early market entering even if customers are not ready to accept it (for example, they offer a customized car or tour. However, their customers are not ready to pay extra for this service). Moreover, they have electronic databases

Table 2: Component loadings matrix

Indicators		Factor loadings			
Keywords	Type	Electronic supply chain	Knowledge management	Intangible assets	Customer preference and support
The importance of manufacturing and supply chain objectives	Mean of 8 items	0.824	—	—	—
Problems in regard to production and supply chain channels	Mean of 8 items	0.880	—	—	—
Adaptive and adequate supply chain management	Mean of 15 items	0.838	—	—	—
Flexibility of manufacturing activities	3-point item	0.796	—	—	—
The amount of international row material sourcing	5-point item	0.749	—	—	—
Average manufacturing cycle time and average delivery time	Mean of 2 items	0.871	—	—	—
The level of possible customization options	3-point item	0.823	—	—	—
The extent of Internet usage in gathering information from customers	3-point item	0.782	—	—	—
The extent of Internet usage for connecting to chain partners	3-point item	0.789	—	—	—
Ability to do B2B transactions on WWW and/or EDI	5-point item	0.835	—	—	—
Ability to do online B2C activities and transactions	5-point item	0.860	—	—	—
Ability to do intra-organizational e-commerce activities	3-point item	0.843	—	—	—
Knowledge management strategies	5-point item	—	0.783	—	—
Alignment of knowledge management initiatives with overall business strategy	3-point item	—	0.876	—	—
Flexibility of organizational structure to promote knowledge management efforts	3-point item	—	0.835	—	—
The importance of knowledge management objectives	Mean of 11 items	—	0.894	—	—
'Personality-related' characteristics of service representative	Mean of 3 items	—	—	0.862	—
'Performance-related' characteristics of service representative	Mean of 3 items	—	—	0.884	—
The culture environment of company	3-point item	—	—	0.816	—
Customer willingness to buy customized product	5-point item	—	—	—	0.836
Customer willingness to pay extra for customized product	5-point item	—	—	—	0.827

Loadings <|0.30| are not shown for the sake of clarity.

and valuable knowledge repositories of customer feedbacks to improve customer relationships and utilize knowledge gathered from them. However, the market and customers are not ready to pay a premium for that. If the market becomes more competitive and customers become more value seekers, these firms will have significant potential and opportunities to benefit. We define firms belonging to Cluster 2 as *Infrastructure management* (29.189

per cent), because of their highest levels of electronic supply chain and intangible assets. These firms use the Internet to link to suppliers, distributors and other internal and/or external chain partners. They show high ability to make communications, collaborations and transactions on WWW and/or EDI. Actually, this cluster includes firms with flexible production processes and manufacturing systems, integrated logistics information systems and coordinated supply
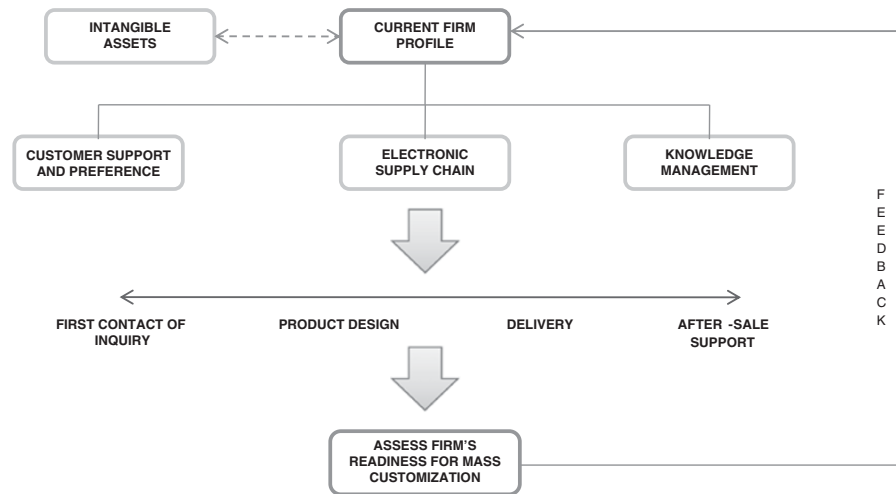
Figure 3: Validated, final version of FIRM.

Table 3: Final centroids for the three-cluster solution

Dimension	Cluster		
	Product innovation	Infrastructure management	Not ready firms
Percentage of proportion	**34.05**	**29.19**	**36.76**
Electronic supply chain	0.03381	0.89016	−0.73821
Knowledge management	0.91744	−0.75422	−0.25104
Intangible assets	−0.06642	0.11788	−0.03208
Customer support and preference	−0.59370	−0.13488	0.65715

chain links. The culture environment of these firms is collaborative with a higher degree of 'performance-related' service representative characteristic. The low level of knowledge management is perceived as the weakest point of this cluster. In other words, they do not integrate the information gathered from customer feedback and electronic interactions with expertise gained from employees to evolve product and service offerings for customization. It is noteworthy that inter-departmental knowledge management team must be flexible to promote knowledge management efforts. Furthermore, in this cluster, the customer's readiness to accept mass-customized products is nearly lower than average. It leads to implications for more investment on acquiring new customers. Firms must encourage their

customers to buy mass-customized products through different advertising campaigns. Eventually, Cluster 3 includes *Not ready firms* (36.757 per cent). They express generally lower-than-average levels on electronic supply chain, knowledge management and intangible assets, as well as the highest score on customer support. Remarkably, these firms have the lowest readiness for electronic supply chain and reversely the highest readiness of customers. This means that firms belonging to this cluster have suitable opportunity to develop and utilize mass customization strategies and there exists a viable market of customer for mass-customized products. On the other hand, they suffer from the lack of integrated production control and planning, manufacturing, distribution and order management processes. Inability to manage

knowledge repositories of the firm is perceived as another of their weaknesses. The culture environment is mostly hierarchical in structure and only rewards individual accomplishments. In fact, this cluster is to some extent underdeveloped and vulnerable. Hence, managers of these firms should be more aware of their advantageous situation and opportunities.

In conclusion, there are important points for managers to consider when they want to develop suitable mass customization strategies for their firm. In the following section, this issue will be addressed. We conducted a validation procedure suggested by Lattin et al[46] to gain further support for the three-cluster solution. The sample is divided into two subgroups by applying a random selection procedure. The calibration sample included 117 users (about 70 per cent), whereas the validation sample encompasses 47 users (about 30 per cent). First, we ran a k-means cluster analysis on the calibration sample and saved final centroids. The resulting three-cluster solution was nearly identical to the whole sample analysis. Second, we classified firms from the validation sample using final centroids from the calibration data. This classification is denoted as C_1. Third, we ran a k-means cluster analysis on the validation sample and used final centroids to classify firms from the validation sample. This classification is denoted as C_2. At the end of this procedure, we cross-tabulated C_1 versus C_2 and assessed the agreement between the two solutions. The proportion of agreement between C_1 and C_2 was achieved by computing the Rand Index[46] over all the possible combinations between subjects in the clusters. We found a Rand Index of 0.919, which shows a significant agreement between C_1 and C_2. It suggests that the clustering model has a strong capacity to classify firms relative to their level of mass customization readiness.

DEVELOPING RELEVANT MASS CUSTOMIZATION STRATEGY

On the basis of the operational strategy, information systems, marketing and mass customization literature,[21,47–49] as well as brainstorming with the panel members and company managers, we were able to develop mass customization strategies for each cluster of FIRM. These policies determine the optimal SCM and CRM actions along the 'first contact of inquiry-after sale support' continuum. For each cluster, Table 4 shows the cluster name and characteristics, the associated customization approaches and underlying rationale and some directions for SCM and CRM actions.

The choice of customization strategy for an enterprise is highly dependent on its organization and business environment. It may not be the panacea for all organizations. For example, Alford et al[47] suggest three distinct mass customization strategies – *core, optional and form customization* – in the context of automotive industry. Core customization, which involves customers in the product design process, may be a suitable strategy in 'product innovative firms' (like low volume specialist vehicles). Optional customization is an adequate strategy in 'infrastructure management firms'. In this strategy, customers are able to choose their product from a very large number of options. Finally, in form customization strategy, customers are able to have limited changes to the actual product at the dealer or retailer. 'Not ready firms', may benefit from utilizing this strategy as the first step to enter mass continuum. Lampel and Mintzberg[50] define a typology of five strategies through the mass continuum. It includes pure standardization, segmented standardization, customized standardization, tailored customization and pure customization.

Table 4: Managerial options resulting from cluster analysis

Managerial options	Cluster		
	Product innovation	Infrastructure management	Not ready firms
Cluster characteristics	First movers, collaborative customizers, transparent customizers, the lowest customer support, highest knowledge management, nearly average level of electronic supply chain and lower-than-average intangible assets	Close followers, adaptive customizers, cosmetic customizers, the highest levels of electronic supply chain and intangible assets, the lowest level of knowledge management and nearly lower-than-average customer support	Late followers, customized standardizations, the lowest electronic supply chain, as well as lower-than-average levels on knowledge management and intangible assets, the highest score on customer support
Customization approach and underlying rationale	*One-to-one personalization or co-creation* These firms have enough experts to address needs, which were not met and perhaps even not sensed before. Advertising campaigns, channel marketing, Internet marketing and promotions are suitable strategies to handle customers which are adverse to cooperation with the firm and social interaction	*Mass customization or customerization* These firms may apply more advanced customization forms, if they pay more attention to their knowledge infrastructure. Differentiation, lower cost, supplier relationships outsourcing, forward integration distribution network of customer relationship developments and cross-functional organization structure are some strategies to pursue mass customization	*Light product versioning or mass customization* The strategies of these firms are mostly near to pure standardization and segmented standardization. In fact, if a product presented by these companies being customizable, the value chain is ready, the technology being available and market conditions being appropriate then substantial support exist for the move to mass customization
Directions for SCM and CRM actions	• Change market environment by being pioneer in offering new opportunities of mass customization • Visualize the final prototype of ordered products and provide dynamic help • Use advanced manufacturing and information techniques like lean production, JIT delivery and TQM to improve flexibility and responsiveness • Cooperate with customers to develop new services, offering personalized interface • Apply collaborative customizer or transparent customizers approach • Target for CRM action	• Zero marginal cost actions by using the Internet and Web platforms to build new relationships between company and its customers • This relationship evolves positively in the future and suggests advanced forms of customization • Improve organizational learning capabilities • Embodied intellectual assets in the total business system • Actively acquire and update knowledge bases • Decrease risks by utilizing innovative knowledge sharing processes • Periodically assess current and/or potential customers and markets to see if preferences have changed	• Zero marginal cost actions as well as a light product versioning, if the expense of handling mass customization is much more than it's returned benefits and revenue • Apply mass customization as an ideal strategy to zero defects • Modularity is considered to be a necessary requirement for the implementation of mass customization • Gain economies of scale and scope • Redesign manufacturing and sale processes • Executives must be open to new ideas and the culture of organization should be consistent with the changes • Synergized and interrelate elements of supply chain and manufacturing

The 'product innovative firms' are generally first movers with enough experts to manage the latent needs of customers. They may gain market share and profits at the expense of the conventional sellers.[51] Offering novel products, addressing needs which were not met and perhaps even not sensed, are the most viable policies to

create a new market.[52] However, their low level of customer support expresses the low propensity of customers to cooperate with the firm. In other words, customers would prefer to go for an off-the-shelf product and are not likely to invest time and money in a configurable product. Collaborative strategies as well as utilizing advertising campaigns, channel marketing, Internet marketing and promotions may be suitable strategies to handle this issue and to motivate customers to interact and buy mass-customized products. They may apply mass customization through *collaborative customizer* or *transparent customizers* approach. In the first approach, firms establish a dialogue to help customers express their needs and then develop customized outputs to meet these needs. In the second approach, firms provide custom products without letting customers know those products have been customized for them.[49] In some business contexts, market conditions may not be appropriate to persuade customization efforts. In this situation, firms need to change the market environment by being a pioneer in offering new opportunities of mass customization. This creates a new competitive environment, allowing customers to seek products closer to their ideal. Visualizing the final prototype of an ordered product using advanced interactive product Web sites would be another strategy to motivate customers. Firms belonging to this cluster express nearly average electronic supply chain. Using advanced manufacturing and information techniques like lean production, JIT delivery and total quality management (TQM), they could improve flexibility and responsiveness. Moreover, there would be an increase in variety and customization without a parallel increase in costs. Considering the significant level of knowledge management and admissible level of supply chain readiness of this cluster, we argue that there is substantial evidence for moving to one-to-one

personalization and that co-creation will exist if customers become more involved.

The 'infrastructure management firms' are generally close followers. They are characterized by the highest electronic supply chain and intangible assets. The Internet reduces the cost of managing multiple prices to nearly zero. It reduces the cost through standardized networking technologies and creates new relationships between companies and their customers. These firms show a low level of knowledge management, thus suggesting a potential risk of not utilizing innovative knowledge sharing processes. By improving organizational learning capabilities, which are the ability to value, assimilate and commercialize new external knowledge, firms would respond quickly to new customer demands and market changes. Managers should recognize the value of intellectual capital as a major source of sustainable competitive advantage. Notably, intellectual assets should be embodied in the total business system. Companies must actively engage in acquiring and updating their knowledge bases in order to evolve competitive strategy on a low-cost, price discounting strategy to more advanced market strategies, which are difficult to duplicate.[53] Furthermore, these firms indicate lower-than-average customer support and involvement. On the other hand, for successful mass customization implementation, customers should become more involved and willing to sacrifice time and money. Obviously, managers should not adopt mass customization strategy if the market is not yet demanding customized offerings. However, they should periodically assess current and/or potential customers and markets to see if preferences have changed. We claim that mass customization and customerization would be the right strategy for this cluster. However, we believe that substantial evidence for moving to one-to-one personalization, co-creation and even reverse marketing will exist if their knowledge infrastructures

improve considerably. Differentiation, lower cost, supplier relationships (or alliance) outsourcing, forward integration distribution network of customer relationship developments and flatter, cross-functional organization structure are some strategies to pursue mass customization.[54] We suggest that *adaptive customizer*, which allows customers to buy a standard product with the capability of modification based on their needs, and *cosmetic customizers*, which means presenting a standard product differently to different customers, are two suitable approaches to apply mass customization in these firms.[49]

Finally, the 'not ready firms' are generally late followers with strategies mostly near to pure standardization and segmented standardization. If products presented by these companies are customizable, customer demand for variety and customization exist in the market, the value chain is ready, the technology being available and market conditions being appropriate then substantial support for moving to mass customization will exist. In addition, when customers differ sharply in their preferences for certain attributes of a product, customization may truly add value.[21] Modularity may be viewed as the first step to gain 'mass' in the firm's operational strategies.[48] It enables the mass customizer to reduce the costs of variety. Some perquisites of modular product design are as follows: first, inputs must be ready when needed. Second, components must be highly standardized. Third, organizational structure must enhance the coordination among modules.[54] One of the requirements of mass customization is that the value chain should be ready and knowledge must be shared among employees and channel members. As discussed above, considering low levels of electronic supply chain and knowledge management indicate that these firms are not ready for mass customization.[4] Firms belonging to this cluster must try to gain economies of scale and scope which enable customized products to be as affordable as possible.[1,55] Moreover,

they should redesign their manufacturing and sale processes in order to reduce setup and changeover times and the cost of variety. To achieve mass-customized manufacturing, firms should gradually synergize and interrelated elements like modularity, technologies such as CAD/CAM/CAE, ERP, MES, PDM and SCM systems, JIT-based Pull System, TQM and cross-functional team. Executives must be open to new ideas and the culture of organization should be consistent with the changes. Furthermore, financial issues is one the obstacles – especially in SME's – which oblige managers to master a structured low-risk approach to become a mass customizer. In conclusion, mass customization is a performance ideal strategy in the way that zero defects in respect of quality.[2] Considering the high level of customer readiness and the potential of the market, we suggest that this cluster would benefit from applying mass customization strategies. Note that customer satisfaction is the main goal in developing a marketing strategy. Moreover, if the expense of handling mass customization is much more than it's returned benefits and revenue, mass production and a light product versioning, as well as advocating zero marginal cost actions, will be an appropriate strategy.

DISCUSSION, CONCLUSION AND FURTHER RESEARCH

Mass customizing enterprises give customers the opportunity to have a product anytime, anywhere, any way and in any volume they want, along with mass operation benefits.[2]

In this article, we proposed and validated FIRM, a new managerial framework of assessing FIrms' Readiness for Mass customization. This framework would help strategic decision-makers to identify the particular policies and configurations necessary for their business. Moreover, we provide clear directions on how to manage customization policies for each firm

belonging to special cluster with concerning multiple variables.

FIRM is based on five dimensions, which are prerequisites of choosing a mass customization strategy: customer support and preference, manufacturing and supply chain, knowledge management, e-commerce and intangible assets. To apply mass customization as an effective business strategy, these dimensions have to work well individually and together. Finally, using Delphi method and brainstorming sessions, we developed, pretested and then administered a questionnaire for firms profiling in today's marketing and production environment. Firms may utilize this questionnaire as an actionable tool to assess their readiness for mass customization. We obtained satisfactory levels of Cronbach's α at the end of the purification process. The results imply that the five-dimension structure of FIRM may be reduced to a four-dimension construct. Three of these four dimensions nicely corresponds to customer support, knowledge management and intangible assets. The new dimension named 'Electronic Supply Chain' is equal to manufacturing and supply chain readiness and electronic commerce. We suggest monitoring the critical indicators of the four components as a systematic activity, which enables continuous refreshing of firm classification and profiling.

Using k-means cluster analysis results, three different groups of firms are founded. Each of them expresses specific characteristics with regard to their mass customization readiness. According to the unique attributes of each cluster, we devote particular names to them including: (a) product innovative, (b) infrastructure management and (c) not ready firms. The culture environment of 'Product innovative firms' is mostly employee center and team oriented. The economy of this cluster is based on innovation, early market entering and being the first mover. Considering the

significant level of knowledge management and admissible level of supply chain readiness of this cluster, we believe that substantial evidence for moving to one-to-one personalization and co-creation will exist if customers become more involved. The 'infrastructure management firms' are generally close followers with a collaborative culture. We claimed that mass customization and customerization would be the right strategy for this cluster. However, we believe that substantial evidence for moving to one-to-one personalization, co-creation and even reverse marketing will exist if they pay more attention to their knowledge infrastructure. Finally, the 'Not ready firms' were generally late followers with a hierarchical culture that only rewards individual accomplishments. The competitive strategy of this cluster was based on low costs and a price discounting strategy. We argue that if the expense of handling mass customization is much more than it's returned benefits, mass production and a light product versioning, as well as advocating zero marginal cost actions will be an appropriate strategy for this cluster. However, considering the high level of customer readiness, we suggest that they would benefit from applying mass customization strategies either. Furthermore, the findings indicate that the percentage of not ready firms in our field study is more than other clusters.

Different levels of investment in mass customization may be implemented regarding the degree of technological and organizational changes that the company wants to apply to its own production system and organization. Mass customization may not be the panacea for all organizations. We developed mass customization strategies for different clusters of firm. These policies aim at defining the optimal form of mass customization strategies along the 'first contact of inquiry-after sale support' continuum, thereby addressing SCM and CRM actions.

Future research may extend our study and its applications. First, a longitudinal data collection is the most urgent step needed for measuring the applicability of FIRM over time and in a dynamic perspective. Second, we think it would be beneficial if further research with larger samples was accomplished in order to describe clusters relative to differences in firm characteristics and objectives likewise. Additional survey research may be a third suggestion for future work. It could support generalizing the results in other country settings with a variety of industrial cultures as well. Fourth, further evidence should establish on how the joint orchestration of all these dimensions creates superior customer–relating capability. We suggest such studies need to integrate a survey–based investigation with qualitative techniques. The qualitative research may involve in–depth case studies of firms with different levels of mass customization policies. A combined method approach may provide a richer understanding of how these strategies would apply with other marketing practices. As a final suggestion, it is beneficial to study the effects of recommended mass customization decisions and clusters on the firm's revenue model and financial performance as well.

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