

Success Mass Customization: The Role of Market Segment Favorableness

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Abstract: Mass customization (MC) emerged as a new paradigm that shifted from mass production. It achieves both volume and cost efficiency of mass production and customization capabilities at the same time. The challenge for manufacturing managers is to find ways to cope with the market and increase product variety through MC without affecting lead-time, cost or quality. Based on the previous literature review, a conceptual summary of MC is discussed. According to the conceptual summary, a model is built to discuss how each of the elements associated with MC contributes to improved firm performance. It further proposed that the market segment favorableness influences the relationship between MC and firm performance.

Keywords: Mass customization, Market segment favorableness, Flexibility, Learning organization

I. Introduction

Mass production (MP) is concerned with producing standardized goods in large quantities and at a low cost. Having been the dominant concept in the U.S. manufacturing industry since the 1800s, MP reached its peak in the 1960s [12] [15]. Over the past few decades, however, MP has faced challenges by new competition, including input instabilities [34], dynamic demographics [12] changing needs and wants [28], market turbulence [34], economic cycles, and uncertainties [34] [38], as well as product and process technology shocks [18] [21]. As a consequence, a new paradigm is called for in which a wide spectrum of individually customized goods and services are created cost-effectively. Such a transition from MP to MC not only has led to higher customer satisfaction but also becoming a competitive advantage in the global market place in the 21st century [34].

MC is concerned the ability of a firm to produce a variety of customized products quickly, on a large scale, and at a cost comparable to mass production [34]. While industry adoption of MC is spreading around the world, theory development in this area is lagging. The existing literature reports three major streams of research on MC. The first group of researchers focuses on comparison of MC with MP [12] [15] [31]. They view MC as a new paradigm in which variety and customization replace standardized products, heterogeneous and fragmented markets are generated from once homogeneous markets, and a more flexible, dynamic organizational structure replaces the previous stable one.

The second group focuses on the relationship between the enablers of MC and MC capability. Tu, Vonderemse, and Ragu-Nathan [42] suggest that specific manufacturing practices such as re-engineering set-ups, pull production, and preventive maintenance facilitate MC. In the view of Duray, Ward, Milligan & Berry [13], modularity is a key to achieving MC. Hart [21] identifies four pillars for MC: customization sensitivity, process amenability, competitive environment, and organizational readiness. The third group of researchers emphasizes the significant contribution of MC capability to organizational performance. They contend that successfully implementing MC can improve the performance of a firm. Obtaining and accumulating data about customer preferences in the MC process improves learning about market trends and the trade-off made in choosing products, which in turn helps to retain the customer base [36]. Firms with high levels of MC capabilities will provide high value to the customer [41]. Other benefits of MC include increased market share, increased customer knowledge, reduced order response time, reduced manufacturing cost, and increased profit [2].

Most of the existing MC studies do not have a unified understanding or definition of MC. MC is often confused with direct deliveries, maximum product variety, e-commerce, one-one-one marketing, or personalization of communication flows. In addition, the existing MC literature does not emphasize the importance of fit between market conditions and a MC strategy. The purpose of this paper is to attempt to answer questions regarding a successful MC, specifically: (1) How should we understand MC? Why the high expectations of MC have not yet been met on a large scale? Will the pursuit of MC be successful? (2) How MC influences the firm performance? How important is the market, the needs of individual consumers, in moderating the relationship between MC and firm performance. The proposed study contributes to the MC literature by summarizing and defining the common elements of MC. A theoretical model is introduced to describe the relationships between those major elements and firm performance. The most important, it attempts to fill the gap in this field by investigating the moderate impact of market segment favorableness on relationship between MC and performance. Previous research on MC mainly focuses on the supply side [11] [44], i.e. the technological progress and supply shock, which appears to be under control. However, research and practice today focus on the dynamic demand side. The markets, which are characterized by demanding consumers, are not under control. This paper

examines the impact of market segment favorableness to emphasize the importance of the dynamic demand side.

II. Conceptual Model and Propositions

As illustrated in the theoretical model in Figure 1, MC is proposed to positively associate with firm performance. Based on the review, MC, in this paper, is viewed as a manufacturing management system including five major elements: customer-driven, low cost and high quality, technology, flexibility, and learning organization]. Each of these elements is proposed to positively related to firm performance as well. It is also suggested that the level of market segment favorableness affects the strength of the relationship between MC and firm performance. The following subsections introduce the background literature of each variable in the model.

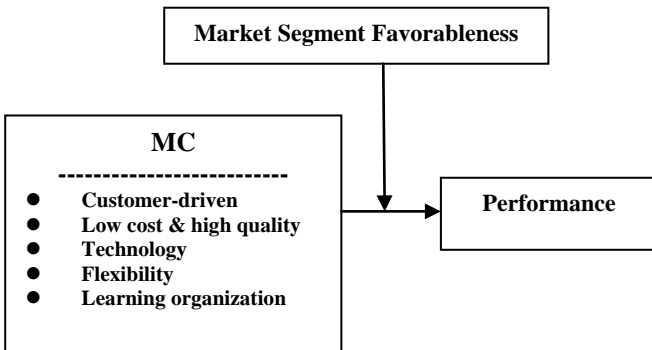


Figure 1. Theoretical Model

Mass customization and firm performance

This literature review reveals how the broadest definition of MC is treated as a link that brings together necessary modules instantly and without cost to achieve competitive advantages. This visionary concept defines MC as the ability to profitably provide customers with individually designed products and services anytime, anywhere and anyway they want [40]. The narrower definition, on the other hand, from a practical concept view, defines MC as a method that uses flexible processes and organizational structures to produce individually customized products and services at the low cost of a standardized, mass production system.

Nine articles are reviewed to summarize the common elements of MC. These articles were selected because they are often cited in the literature and they all discuss MC from a comprehensive and conceptual perspective. Below are the twenty-one elements of MC identified and synthesized from different views of these articles:

- | | |
|--------------------|-------------------------------------|
| Product variety | Customer-driven services |
| Low cost | High volume |
| High quality | Customized goods |
| Fast delivery | Reduced setup and change over time |
| Reduced cycle time | Redesign of manufacturing processes |

- | | |
|------------------------|-----------------------|
| Modularizing | Technology |
| Flexibility | Responsiveness |
| Continuous improvement | Employee involvement |
| Customer involvement | JIT-based pull system |
| TQM | Cross-functional team |
| Learning organization | |

Each element is agreed upon by at least two authors. All authors mention these elements more or less as the principles that reinforce the central idea of MC.

As some of the elements are overlapped or closely related, after careful review, they are condensed and synthesized into five major elements: customer driven, low cost & high quality, flexibility, technology, and learning organization. These five major elements are listed in Table 1.

Table 1 Elements of Mass Customization

	1	2	3	4	5
Davis (1989)	x	x	x	x	
Pine et al. (1993)	x	x	x	x	x
Hart (1995)	x	x		x	
Kotha (1995)	x	x	x	x	x
Ahlstrom et al. (1999)	x	x		x	x
Tu et al. (2001)	x	x		x	x
Silveira et al. (2001)	x	x	x	x	
Duray (2002)	x	x		x	x
Kakati (2002)	x	x	x		x

1. Customer-drive
2. Low cost & high quality
3. Technology
4. Flexibility
5. Learning organization

Overall, MC should be viewed as a manufacturing management system including the above five major elements. Within such a system, customer-driven, low cost & high quality, technology, flexibility, and learning organization have to function well and must be linked tightly to form a coherent, integrated whole. A set of interrelated techniques and programs is required to allow for working through different groups either inside or outside the organization. A firm that successfully implements MC has the greater ability to tailor products, services, and the transactional environment to individual customers. By catering to the unique needs and wants of individual customers and by providing the right product to the right customer at the right time, such a firm can serve its customers better, improve customer satisfaction, build loyalty, and increase retention. High MC capability is a powerful competitive advantage to increase its sales growth, shorten production throughout times, and maximize its investment. The five major elements are the indicators of MC. The more these elements are included into the manufacturing management system, the higher the degree of MC, and the better the performance.

Proposition 1: MC is positively associated with firm performance.

Customer-driven

The primary goal of firms adopting MC is to make and offer a product that the customer wants when the customer wants it. As the market has changed from homogeneous to heterogeneous, demand for individual products is now unstable [34]. The large demand for standard mass-market products has fragmented into demand for different flavors of similar products. It is important for manufacturers to provide new products that meet customers' needs. These products should be different from what is already in the marketplace. The objective of MC is to satisfy the customer [21] [31] [34].

Companies are customer-driven when producing customized high quality products with general-purpose equipment and highly skilled workers. Also, companies produce with greater variety and response and with more quickness to the new market, which is smaller and more uncertain [2] [40]. The level of customer involvement in manufacturing plays an important role in determining the degree of uniqueness of the product and the type of customization. The earlier the customers are involved in the design results in the higher degree to which the products or the services are customized. If customer preferences are only adopted at the final assembly stages, the degree of customization will not be as great. Customers' involvement provides a practical indicator of the relative degree of product customization [37] [38].

Proposition 1a: The degree of customer-driven is positively related to firm performance.

Low cost & high quality

Quality and low cost are two forces related to the traditional tradeoff prevalent in manufacturing. MC shows that companies can overcome this traditional tradeoff. In other words, companies can have it all. In MC, production is effected upon receipt of an order instead of a forecast, which lowers the inventory costs. Different from mass production, MC lowers the cost through economic of scope; that is, lower the cost by increasing the variety of the products or services. Mass customized products may still be produced in relatively large quantities. Mass production provides low-cost products on a large scale. However, it is limited in its customizability when compared to MC. One of the major distinguishing features of MC is the capability to meet customers' needs precisely while maintaining economies of scale.

MC offers unique products in a mass-produced, low-cost, high volume production environment. This method minimizes costs and at the same time maximizes individual customization by creating modular components that can be configured into a wide variety of end products and services

[14] [31]. Gains in economies of scale are achieved through the components rather than the products, and gains in economies of scope are maintained by using the modular components over and over in different products. It allows for product development to produce new designs with greater variety and more quickness. The individual modules are mass produced, achieving the economies of scale and thus, a lower cost. "The fact that these parts or modules are standardized allows for MC products to achieve the low cost and consistent quality associated with repetitive manufacturing"[13, p.607].

Many manufacturers use TQM as an effective means to ensure MC finally achieves low cost and high quality at the same time [2] [38]. TQM requires ensuring that things are done right the first time and that defects and waste are eliminated from operations. Companies maintain quality standard in all aspects of its business through TQM.

Proposition 1b: low cost and high quality have a positive effect on firm performance.

Technology

Technology plays a key role in MC. It involves new manufacturing techniques and machines combined with information technology, microelectronics, and new organization practices in the manufacturing process [31] [34] [40]. Technology today enables firms to provide digital content and services customized to individuals on the basis of knowledge about their preferences and behaviors. It creates a linkage between the customer's preferences and the ability of a manufacturer to produce the products based on those preferences [15] [40].

Advanced manufacturing technologies such as flexible manufacturing systems can manufacture assorted products with the same group of machines that are linked by automated material handling systems. Communication and network technologies such as computer-aided design and computer-integrated manufacturing enable direct links between work groups for improvement of response time to customer requirements. Recent developments in internet technology are also being explored to facilitate the implementation of MC [9]. The internet has become the main tool for communicating customer's requirements to the manufacturer. Those advanced technologies collaborating with the right skills, experiences, and expertise can drastically reduce the development time while increasing the effectiveness. One example is the virtual reality system called CAVE (for Cave automatic Virtual Environment) used by companies like General Motors, Caterpillar, and Levi's. CAVE enables people to walk around, without bulky headsets, three-dimensional representations of products. It helps the company to do many activities that could never have been done before, and allows activities that could be done to be completed much faster, more efficiently, and more effectively.

Advanced technology can also support the required channels for communication and collaboration between organizations and their suppliers. It is a tool that firms can use to share different kinds of technical and business information, to support globally dispersed development teams, to test and display product designs and engineering drawings, to manipulate data and create new knowledge, and to manage advanced product development [28]. Technology creates and ensures the efficiency of MC by integrating the organizational networks. It eliminates delays when processing orders and managing product information. Further, it provides efficient means for exchanging product requirements between customers and manufacturer and between manufacturer and suppliers. Customers specify their needs, likes, and dislikes. This information is translated into the manufacturing specifications through technology. Technology reduces the cost through standardized networking technologies and creation of entirely new relationships by interconnection of companies with their customers. Overall, advances in technology helps companies to achieve an integrated manufacturing system that is fast, responsive, and flexible, as well as very low cost at high volumes [15] [26] [37].

Proposition 1c: The use of technology has a positive effect on firm performance.

Flexibility

MC requires flexibility at all levels, such as individual machine, manufacturing system, and manufacturing function. In MC, demand varies because of the different nature of the products; therefore, the manufacturing system should be flexible to produce and adapt to diverse customers' requirements. Companies transferring from an existing manufacturing system to MC should redesign the production system to achieve successful MC. The new system should be redesigned to reduce setup and changeover times, which allows for having a smaller run size and reduces the cost of variety. The new system should also be redesigned to allow all the products to be built by the same process without having to change the setup for different parts. The whole redesign process involves major changes to core processes that require breaking through previously inviolate functional boundaries. Also, the volume of the products should be flexible since the quantities of the demand are not certain.

A flexible manufacturing process allows a company to produce multiple versions of its products with a single assembly line [18]. A firm with flexibility not only needs to provide the products and services that the customers desire, but also needs to deliver the products or services when they want them [2]. In MC, products are manufactured according to individual order; it will take some time to customize the product and to deliver it to the customer. The success of implementing MC depends on how effectively management executes the mass production techniques with a smaller lot size. Most often, customized products are built-to-order, so

there is no end-product inventory kept. The delivery time can be minimized by increasing the commonality between products, implementing fewer processes on the shop floor with fewer setup times, and implementing group technology. Therefore, companies with flexibility are capable of switching between products in a fast-paced and cost-efficient manner.

To achieve flexibility, each individual employee is encouraged to be involved in MC manufacturing. Workers are responsible for planning and supervising their own work. Employees are not only empowered, but they also have access to relevant information to change the way work is performed. An individual worker knows how his/her function affects others. The workers are capable of performing a diverse range of jobs. In MC, employees are assigned to work in a cross functional team. That is, even if an individual worker focuses on a specific objective, he or she is still responsible to work to improve coordination and innovation across divisions and to resolve mutual problems. Thus, the employees can accurately respond to a customer's need despite the increased uncertainty and complexity. The success of MC requires flatter organizational structures-with a focus on a high degree of cross-functional integration. In general, a flexible manufacturer has the ability to adapt to both the fluctuations in demand and many other changes in its environment [34] [41] [42].

Proposition 1d: Flexibility has a positive effect on firm performance.

Learning organization

As products and technologies are constantly improved or replaced, Baird and Griffin [5] suggest two types of learning: learning for performance and learning from performance. In MC, investigating the consumption frequency of products in order to better understand a customer's wish is a type of learning for performance. To pursue continuous improvement in production methods in order to achieve the manufacture of low-cost and high quality goods and services is a type of learning from performance.

In a learning organization, all aspects within the organization from people, processes, organizational structures, and technology, are geared to provide customers specifically what they need and want. The more a company learns from its customer, the better it can provide exactly what he wants--when, where, and how he wants it [14]. Also, a customer will most likely stick with the company, even if a competitor can provide the same products with the same conditions--because the customer has already involved himself in a learning relationship with a firm and would be less likely to spend an excessive amount of time and energy to teach the competitor what the firm already knows [26] [38]. The more the company learns from each customer about his individual wants, needs, and preferences, the more difficult it will be for him to obtain an equivalent level of service from a competitor. Because the company knows

more about its customers than any competitor and its products are tailored precisely to those customers, clients will keep coming back and will tell their friends and associates if they are satisfied with their experiences. This helps companies to increase revenue, market share, and number of customers [28] [31] [34].

Proposition 1e: Learning organization is positively associated with firm performance.

Market segment favorableness, MC and firm performance

Market segmentation is a process used to divide a market into different groups that have common requirements and to group the marketing actions related to the market segments [30]. MC sees each customer as a segment and treats each customer separately by fulfilling his/her needs and desires [36] [43].

The market demand environment can be classified into two categories based on different needs of customers: make-to-stock (MTS) environment and make-to-order (MTO) environment [20]. In the MTS environment, the customer goes into the shop and buys products from the available stock. The company does not ordinarily provide customer promise dates. Since finished goods are stocked, the customer is most often served from inventory. If there is insufficient inventory for a specific request, the customer must be told when more will be available or, if there is partial allocation of the order, told what portion of the request can be satisfied. In this case, the customer decides which product to buy and when to buy it. The company decides what products to make and when to make them [23]. The level of customers' favorableness of MC in the MTS environment is low. Customers are not likely to invest time and money in a configurable product. Instead, they will prefer to go for an off-the shelf product.

In contrast, in an MTO environment, customers look over the catalogs of products, choose one, and request the company make a specific design. In the MTO environment, the primary activity is to control the progress of customer orders to meet the promised delivery dates [23]. Any engineering or manufacturing changes must be related to the master production schedule to determine their impact on the final delivery to the customer. In this environment, there's communication from the customer (a request for a product) and to the customer (a delivery date) through the demand management module [3]. Later there maybe additional communications with the customer to respond to order status requests [20]. In the MTO environment, customers have a high level of favorableness of MC and thus would likely to provide information, seek views of the company, and be involved in making decisions on the products.

Not all customers want individualized products. Companies should first analyze the heterogeneity of customer needs and the rate of change for those needs to define whether customers are favorable to customization [21]. The final

outcome of MC depends on the level of favorableness of each market segment [37].

The market environment is an important contextual factor that helps to determine firm performance (Silveira et al., 2001). When market segment has high favorableness of MC, customers in this market segment are looking for individualized products or services, customers would like to provide information and seek views of the company, and they are responsible for making decisions on the product service. In addition, high favorableness represents customers' willingness to spend time designing the product, to pay the price premium, and to wait to receive the finished products [7] [21]. Companies learn from the customers to better understand their desires. Therefore, companies are able to capture important market trend from their customers and have much higher retention rates for their customized products than the competitors. Consequently, companies could enhance the customers' loyalty.

On the other hand, when the level of market segment favorableness of MC is low, customers are not likely to invest time or money in a configurable product. Instead, they will prefer to go for an off-the-shelf product. It is a waste for companies to put efforts in increasing products variety, or improving its flexibility or responsiveness. Implementing MC in those market segments with low favorableness of MC will not only increase unnecessary costs, but also create customer relations confusion [24].

Proposition 2: The effect of MC on firm performance is stronger for firms operate in market with high market favorableness than for firms in market with low favorableness.

III Conclusions and Limitations

This paper examines the common elements of the definition of MC based on extensive literature review. It synthesizes these elements and extracts five major elements that are shared by the previous researchers. All of these elements associated with MC are expected to contribute to improve firm performance. In addition, the present study also investigates the relationship between a company's MC capability and firm performance depending upon the level of market segment favorableness.

The present study contributes to extant MC research by providing a comprehensive understanding about MC and increases the understanding of how people evaluate MC implementation. To successfully implement MC, a firm must emphasize the integration of all internal activities with its potential customers. This integration process is crucial for the success of MC strategy. MC is not just adding a few new technological wrinkles to an already existing organizational framework; adopting a MC strategy implies considerably more. It represents a major paradigm shift in the way business is conducted and is destined to have enormous ramifications in industry after industry. Most

importantly, the paper attempts to fill the gap in this field by investigating how the market segment favorableness affects the strength of the relationship between MC and firm performance. This part is usually treated as an uncontrollable factor and largely ignored by existing literature. This could be used for managers to identify whether there is support for the move to MC.

This paper only provides the testable propositions. Consequently, further research is needed to examine whether these propositions are valid. In addition, market segment favorableness is a new concept developed in this study and needs to be empirically tested to decide whether it can exist as moderator for firm performance.

References

References available upon request from Wai Kwan Lau at 940-565-3166.

Background of Author

Wai Kwan Lau is currently a doctoral student at University of North Texas. Her areas of research include leadership, organizational learning, knowledge management, and manufacturing strategy.