

OPPORTUNITIES TO ADOPT MASS CUSTOMISATION – A CASE STUDY IN THE BRAZILIAN HOUSE BUILDING SECTOR

Patricia André Tillmann¹ and Carlos Torres Formoso²

ABSTRACT

Mass customisation stands for the ability to develop high value-added products within short time frames and at relatively low costs. This strategy is well known in manufacturing, where it has been widely used for competitive advantage. By contrast, the house building industry in Brazil has been criticized for the lack of effectiveness in dealing with the diversity of customer requirements. In low-cost housing, for instance, product flexibility tends to be very limited, due to the fact that most housing programs adopt mass production core ideas in their conception. This paper presents some interim results of an investigation which aims to identify opportunities and barriers for introducing a mass customisation strategy in the Brazilian housing market. A case study was carried out in a company that develops and builds house building projects for lower middle class customers. Dwellings are commercialised after the completion of the design stage and before they are built, making it possible for costumers to adapt to some extent the dwellings in order to suit their needs and expectations. An analysis of this company's product development process (PDP) revealed that there are many obstacles to overcome before a mass customisation strategy can be fully implemented. These obstacles are related mainly to legal and economical issues related to existing housing provision forms in Brazil, inherent characteristics of construction processes and managerial difficulties. However, some opportunities were also found, such as high degree of costumers involvement, the company's concern to increase product value, and willingness to improve managerial processes. Finally, based on main findings, a set of guidelines for improving the PDP in terms of supporting the adoption of a mass customisation strategy is proposed.

KEY WORDS

mass customization, design flexibility, product development, house building, low cost housing

INTRODUCTION

There has been a growing concern in the house building industry with the development of products that are usable for a wide range of people and

adaptable to their changing needs (Barlow and Venables 2004). In manufacturing, this type of demand has resulted in a new production philosophy known as mass customisation, which has been pointed

¹ Master candidate, Building Innovation Research Unit (NORIE), Federal University of Rio Grande do Sul (UFRGS), Porto Alegre, RS, Brazil. Phone: +55 51 3308 3518, FAX: +55 51 3308 4054, patriciatillmann@gmail.com

² Associate Professor, Building Innovation Research Unit (NORIE), Federal University of Rio Grande do Sul (UFRGS), Porto Alegre, RS, Brazil. Phone: +55 51 3308 3518, FAX: +55 51 3308 4054, formoso@ufrgs.br

out as an effective way to achieve high-value added products within short time frames and at relatively low costs (Davis 1987; Pine 1994; Piller 2003). Although mass customisation has been widely used for competitive advantage in manufacturing, the application of this approach in the construction industry has been very limited.

In Brazil, most housing projects are built through traditional craft-based production processes, and house building companies have often been criticised for the lack of effectiveness in dealing with the diversity of customer requirements (Brandão 1997). In fact, previous research studies suggest that the adoption of a mass customisation strategy in the housing building industry might be a way to efficiently deliver customised homes (Barlow 1999; Leite et al. 2005).

This paper presents some interim results of an investigation that aims to identify opportunities and barriers for introducing a mass customisation strategy in the Brazilian low-cost housing market. This study involves several stages, including mapping customization requirements, understanding the product development process (PDP), analysing opportunities to adopt a MC strategy, and proposing changes in the PDP in order to support such a strategy. This paper is focused on the identification of opportunities to adopt a MC strategy in a specific housing provision form in Brazil, and it is based on a case study carried out in house building company from the South of Brazil. Some major barriers for implementing mass customization in the Brazilian housing market are also highlighted.

MASS CUSTOMIZATION

The term mass customization (MC) was first coined by Davis (1987), referring to the strategy of reaching a large number of customers, as in mass production, and giving them an individual treatment, like in craft production. This concept has emerged in the late 1980s and may be viewed as a natural follow up for processes that have become increasingly flexible and optimized regarding quality and costs (Silveira et al 2001).

A mass customization strategy encompasses the dynamics and trade offs among three processes: product design, supply chain design, and production system design (Guruswamy et al 2004). It is in the overlapping of these factors that trade-offs between product variety, mass efficiency and time to market occur. Therefore, the product development process plays an important role in enabling a mass customization strategy.

The PDP is understood as the set of activities necessary to conceive, design and launch a product in the market, including other activities that occur during physical production or in the interface between design and other processes, such as managing costumers requirements, financial evaluations, suppliers evaluation to co-develop the product as well as collecting costumers feedback and using it to improve next product development cycles (Tzortzopoulos 2004; Rozenfeld et al 2006)

The role of those three processes, production system design, product design and supply chain design, in enabling the adoption of a mass customisation strategy is discussed in the following sections.

PRODUCT DESIGN

Product design should allow a high level of synergy among different solutions, and for that to be possible the product architecture must be considered (Collina 2004). A modular type of architecture enables the mass production of standard elements, which can generate widely differentiated products if combined in different ways (Pine 1994). Therefore, modularity is essential to achieve the benefits of large scale, while involving the clients in the process enables the product to be customized (Duray 2000).

Product customization can take place by adding options to a common platform or by mixing and matching modules to achieve different product characteristics (Mikkola and Larsen 2004). This platform should be developed based on market knowledge, providing options that can satisfy costumers needs (Jiao, Ma and Tseng 2003).

According to Noguchi (2005), MC involves a product that is customisable, by combining its standard parts in different ways, and the provision of a supporting service that enables the capture of costumers' requirements and the customization of the product in accordance with those needs. Therefore, not only product design should allow a synergy among different solutions but it should also be regarded as a service to be provided along the PDP for supporting clients in the customization process.

PRODUCTION SYSTEM DESIGN

The literature emphasizes that production process flexibility plays an important role to enable MC (Barlow 1999; Naim and Barlow 2003). A shift on the production paradigm and the

development of just-in-time production, lean manufacturing, time-based competition and other advantages that come along with this new production philosophy have allowed companies to increase product variety at relatively low costs (Pine, 1994).

Flexible production systems enable companies to explore what has been named as economy of scope. This means that the same system is able to produce a wide variety of products, in a production line that is easy to be reconfigured while still exploring the economy of scale (Szwarcfiter and Dalcol 1997). Moreover, flexible systems allow a quick response to market (Stalk and Hout 1990). The introduction of the Toyota Production System has contributed to increase the flexibility in manufacturing, through the application of principles such as batch size reduction and the reduction of setup time and changeover (Szwarcfiter and Dalcol 1997). Other factors have also contributed for more flexible systems, such as multi-skilled workforce (Upton, 1995), process transparency, and the postponement of customization (Stalk and Hout 1990; Child et al. 1991).

SUPPLY CHAIN DESIGN

The implementation of a mass customisation strategy depends on changes that affect the entire value chain. Therefore, it is necessary to introduce changes in the design of supply chains, from sourcing to final distribution (Duray 2002, Pine 1994). A flexible production system is not enough for introducing such changes: flexibility has to be extended to the entire supply chain (Womack 1995).

According to Christopher (2000), postponement or delayed configuration is a vital element to achieve flexibility.

Modules and components of the product are produced to stock, but final assembly or customization does not take place until customer requirement is known. By doing so, inventory can be held at a generic level while final assembly can lead to a variety of end products. This shift from producing to stock and pulling production to meet customer's requirements is called the decoupling point or the order penetration point (Sharman 1984). Postponement brings the decoupling point closer to final customers enabling customization to be achieved within a very short time frame, giving a quick response to market (Christopher 2000). Outsourcing selected elements of the supply chain can also provide greater flexibility (Mikkola and Larsen 2004).

Moreover, MC is a dynamic strategy, since it depends on the ability to translate customers' demand into products and services. In such an environment knowledge creation and information sharing is vital (Silveira et al. 2001). For this reason, the literature suggests that information technology (IT) plays an important role as an enabler of such strategy by providing a visibility of demand and sharing information. (Yassine et al 2004).

RESEARCH METHOD

The research project involved the study of two housing provision forms from Brazil: the Residential Leasing Program (PAR) and Associative Credit Program (CCA). This paper discusses the results concerned with the latter one. It presents a case study carried out in a small sized construction company that is a leading house building developer in the CCA Program from the metropolitan region of Porto Alegre, in the South of Brazil.

The company develops and builds house building projects for lower middle class customers, who usually need to get a low-interest loan from the government for buying their house. The role of the construction company is to conceive the product, develop the design, gather groups of potential customers and take them to the financial institution. If the design is approved by the bank and there are enough buyers the company receives the money that is necessary to produce the whole housing project or part of it. For each group of at least five clients, the loan is released by the bank. The company should also provide some support for final customers while the dwellings are being built, instructing them about legal issues related to the establishment of a condominium and giving guidelines for the proper use and maintenance of the housing estate. This demands several meetings to be carried out between the home buyers and company representatives while the dwellings are being built. The housing project is, therefore, divided into stages that typically consist of blocks of terraced houses which are built in a sequence. Home buyers start paying their loans back to the financial institution as soon as the blocks of houses are delivered.

The housing schemes developed by the company are mainly low-rise residential buildings, with up to 100 one or two-floor houses with two or three bedrooms. Dwellings are grouped into terraced blocks of approximately 10 dwellings. The main construction techniques and materials used are: load-bearing concrete block walls, pre-cast concrete slabs and ceramic tiles roof.

In order to analyse the opportunities and barriers for the

adoption of a mass customization strategy in this context, it was first necessary to have a better understanding of the product development process. Data was collected through a set of interviews carried out with the company's staff, during a period of four months. The first interview was carried out with the design manager, who was asked to describe the company product strategy and the product development process in detail. Then, another interview was carried out with the production manager, who was asked to provide a fully description of the production process and the relationship with suppliers, and also the main difficulties when customizing the dwellings. These same questions were also asked to the foreman and an intern at the construction site, which allowed a better understanding of how this process was being done in practice.

Other sources of evidence were also important, such as: the analysis of legal documents concerning the rules that have to be followed to develop a product for this type of housing provision; direct observation at the construction site; participation on meetings between the company and the costumers; and the analysis of architectural drawings, users' manual, and other internal documents concerning the company's procedures.

CASE STUDY

PRODUCT DESIGN

The company had a well defined product development process, which is well documented in the quality management system. When a new project is developed usually some incremental improvements are made in the product design, based on lessons learned from the previous project. This

is mostly made in an informal basis, due to the close relationship that the company usually establishes with final costumers. Moreover, through the quality management system, some feedback is systematically obtained from existing costumers.

In early stages of product development, an economic and financial feasibility study is prepared by a team formed by production and design staff, and presented to the company's director, who will decide whether the project will be realized. Usually, a number of alternative design solutions are proposed, and one of the main factors that is considered in the selection of the solution is its cost. Considering the growing cost of land in Brazil, the design solutions should also consider the need to achieve a high occupancy ratio. This represents an important limitation for extending the area of the houses in the future.

Although the houses are repetitive, the product design cannot be characterized as modular. From the point of view of product architecture the project is considered to be an integral product. It consists of load-bearing block walls, with hydraulic and electrical systems closed attached to it. Changes in those systems must be planned well in advance – otherwise they would cause disruptions in the production process. Once walls are built, they cannot be modified because of their load bearing properties (damaged bricks can cause structural failure). Thus, there are some restrictions for introducing modifications later in the design process, and very few modifications in the buildings after occupation are allowed.

Once the architecture and building services design have been finished, they have to be approved by both the financial institution and the city council, which is a major bottleneck of the process. Sometimes, it takes several months for the entire project to be approved by local authorities. Once the design is approved, the company may start advertising the product in the market, and, as explained earlier, start gathering groups of interested costumers in order to sign a contract with the bank.

MARKETING AND SALES

Since dwellings are commercialised after the design stage is finished and before they are built, costumers are allowed to do some changes in the design in order to better suit their needs. The company offers a list of options that can be modified in the dwelling plan, giving a period of 30 days for costumers to request changes. The options are mainly some small changes on electrical and hydraulic systems, such as adding outlets and relocating the kitchen sink, or changes in finishing materials. However, requests other than those on the list are constantly made, often after the deadline established by the company. Some requests that are not in the option list may be very difficult to manage because they can be very unique, such as changing the dimensions of a specific construction element, adding an outlet on a specific place, moving a door to another corner of a room. For each change that is made in the house, the company asks for an additional price.

Furthermore, this customization process is very limited due to some legal restrictions. For instance, the company cannot deliver the dwellings without finishing materials, so if a

client wants to change them, they will receive the standard ones in boxes, and will have to buy and install the chosen materials by their own after the delivery of the dwelling. Requests concerned spatial modifications are very difficult to be fulfilled because local authorities have already approved that plan, and for that reason houses cannot be modified in that respect.

All information collected at the sales point is sent to the production manager. A feedback from the production site is sometimes necessary to check whether it is possible to meet late requests. Sometimes late requests are so important for keeping the costumers that the company decides to follow costumers' demand for customization even though the element that has to be changed has already been built according to the standard design. Moreover, sometimes this complex exchange of information is not properly done, being miswritten by the sales department or misunderstood by the production team. Therefore, not only late decisions by costumers are the cause of rework in the construction site, but also the lack of an effective communication between the sales and production staff.

The company has recently decided to build some dwellings to stock, in order to avoid losing potential clients that do not want to buy a house before it is built. In fact, according to the company's records, it is during the production phase that most of the dwellings are sold. Consequently, while some houses are built accordingly to costumers specifications, others need to be built to stock as standard products. For those clients who buy a house after the production phase has started, the

possibility to make changes is not even mentioned at the sales point.

PRODUCTION PHASE

The production system is designed to build a block at a time, which are usually divided into two production batches, from 3 to 5 units, and it takes around 4 months to build an entire block. After the completion of a batch of units and the necessary infrastructure, these are delivered to final costumers and the company starts to build the next batch .

Since the company provides assistance to costumers throughout the entire production phase, mostly due to issues related to house financing, often this close contact triggers costumers' late decisions, who request a wide variety of changes in a house that was meant to be a standard unit. This situation has led to a dramatic increase in rework, mainly because the production system has not been designed to cope with customization. The production management team is not prepared to deal with changes asked by the customers besides those that had been defined within the 30 days period. Therefore whenever a late decision happens, there are difficulties in managing those changes.

Moreover, being part of the CCA program, there are some rules that the company has to follow and that affects the customization processes. For instance, the financial institution is constantly checking at the construction site, if what is being built matches the design. Therefore, any changes in design should be negotiated with the financial institution in advance. Finishing materials have also to be in place before the dwelling is delivered to final costumers. Sometimes, finishing materials are put in place just to be approved by the financial

institution, and then taken off to meet costumers' specifications.

The building materials are normally bought for each block of houses, and the negotiation with suppliers start at the beginning of the production phase. The company has some steady local suppliers for most materials. For ceramic tiles and bathroom accessories, the suppliers are located far away and they typically deliver standard materials in large batches, which enable the company to buy at a relatively low price. For that reason, costumers have initially one option for finishing materials. Once, the company allowed costumers to bring in their own finishing materials, problems regarding poor quality, and delays on material delivery have made the company to think about giving up this strategy and reduce the flexibility of finishing materials. Those material supply problems also cause problems in the management of subcontractors, since some of them are also hired for large batches of dwellings.

DELIVERY AND MONITORING PHASE

Projects are normally delivered in stages to the costumers, as the blocks of houses are being built. After the delivery of a dwelling, when customers receive their keys, they are requested to fill out an evaluation sheet regarding the company's performance, and provide suggestions for future improvements.

Then, the monitoring phase starts. Besides maintenance services, the company also get feedback from costumers in a post-occupancy evaluation carried out at least after one year of product's use. Collected data is supposed to be analysed by the company's quality management staff, but it is not usually properly processed and analysed. As previously stated,

product improvements are made based mainly on costumers' complaints and lessons learned through the direct contact with final users.

BARRIERS AND OPPORTUNITIES TO ADOPT MC

Based on the case study and also on the regulations of the CCA Program, some barriers and opportunities for introducing a mass customization strategy in the Brazilian low-cost housing market are presented (see Figure 1). Such opportunities require some major changes in the existing product development process, which is not adequate to cope with mass customization ideas.

Some of the barriers for the introduction of MC ideas seem to be related to legal restrictions, mainly concerning local authorities, such as building codes, and the requirements from housing financing programs. Although most of these barriers are external factors, the company has already found ways to deal with some of them in order to adopt a customer focused approach. Barriers such as the

need to deliver all finishing materials and the need to have permission to introduce changes in the approved design have already been solved by the company through a negotiation with the financial institution, which was quite open to those requests.

There are also internal barriers that are mostly related to managerial issues. The main problem is related to the fact that the company introduces changes in their products as a way to satisfy costumers that have not decided yet to buy a house. This is a reactive, rather than a proactive strategy that could be much more effective for obtaining competitive advantage. Other important issues should also be considered, such as the consideration of a modular instead of an integral architecture at the design phase; a flexible production process instead of a process driven by mass production core ideas; and a flexible and more integrated supply chain, instead of isolated suppliers delivering large batch of materials and within a long time frame.

	CURRENT SCENARIO		DESIRED SCENARIO
	BARRIERS	OPPORTUNITIES	
External factors			
Local authorities	Long/difficult process to approve housing plan	Repetitive projects	Increase commonality of design solutions to simplify approval
Financial institution	Original designs have to be followed	Openness to negotiation	Negotiate changes based on clients requirements
	Finishing material have to be delivered	Offer customization service	Partnership with key suppliers
Economical issues	High land costs (restrict amount of space)	Other aspects are customised at the initial design	Design to allow costumers to make changes throughout product's life
Internal factors			
Product strategy	Reactive strategy to unsatisfied costumers Products are difficult to be customised	Customization is seen as a way to increase market share Willingness to improve customization process	Customization should be a competitive advantage (proactive) Develop products that are easy to produce and customise
Product design	Integral architecture	Supporting system to capture clients' requirements	Capture and manage value with efficiency
	List of possible changes is not followed	Use of predefined design solutions	Modular architecture would facilitate product customization Standard range of options, design as a service to support customization
Production system	Time to request changes is not followed	Willingness to improve communication among teams Sequential production	Right moment to customise should be known in advance, transparency
	Lack of information from sales department Large batch size		Effective information supporting customization process, transparency Batch sizes to close match demand
Supply chain	Mass production core ideas (customization is not considered in the process)	Willingness to improve production and customization processes	Flexible and agile production system to cope with customisation
	Designed to mass production Large batches of finishing materials Outsourced services	Close relationship Close relationship with suppliers Fixed suppliers	Designed to add value (decoupling point) Involve suppliers to increase options and reduce batch sizes Flexible workforce

Figure 1: comparison between current and desired scenario

CONCLUSIONS

In this paper, barriers and opportunities to adopt a mass customization strategy in the Brazilian house building sector were discussed. A case study was carried out in a construction company involved in the development and construction of low-cost housing, in which an analysis was made of some key processes.

Some barriers were found to be related to external factors, due to legal restrictions, economical issues and inherent characteristics of construction processes and techniques. Company's managerial difficulties to deliver

customised products were also found, but such internal barriers are easier to overcome, representing opportunities to adopt gradually some MC ideas. This demands a redesign of the product development process. Most changes seem to depend on the company's determination to adopt such strategy: it seems that the first step is to recognize mass customization as a potential competitive strategy. Technological changes or at an operational level do not seem to be enough. It is necessary to bring mass customization into the business strategy and align product development accordingly to strategic

decisions. Some of the MC concepts and practices found on the literature may be useful for redefining the PDP in this context, such as the design of modular products, the increase production process flexibility, and flexible and more integrated supply chains. None of those MC enablers were found in the company's current PDP.

This study intended to explore the possibility to adopt a mass customization strategy in the Brazilian house building sector. Due to time constraints, it was limited to one case study carried out in a single company. Therefore there is a need to investigate

other companies and also other types of housing provision. There is also a need to test the proposed guidelines, investigating not only the possibility to implement such improvements but also to measure the impact of these guidelines on the achievement of MC.

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