APPLICATION OF LEAN PRINCIPLES TO MANAGE A CUSTOMISATION PROCESS

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ABSTRACT

The increasing diversity of dwellers lifestyles and requirements demand changes in the house building industry. The adoption of customisation strategies by constructions companies will increase the product value. Nonetheless, a major challenge is how to increase product variety while maintaining an efficient production process. This paper describes a set of practices developed by a medium-sized construction firm for managing customisation during the construction phase. This firm builds housing units for high-end customers who value quality as well as product flexibility. As a result, customisation is considered a strategic asset by the firm and therefore requires the introduction of several changes in the production process so that customers' requirements could be fulfilled without compromising the efficiency of site and office operations. In order to implement this process, the firm had to change the long-standing view that design changes required by customers harm site operations to the one which recognized that carrying out those changes could in fact add value for customers from the market niche targeted by the firm and thus increase sales. The customisation practices introduced by the firm were strongly based on Lean Construction concepts and principles, such as process transparency, reducing the share of non-value-added activities, increasing output value through systematic consideration of customers' requirements, increasing output flexibility, batch size reduction, focusing on controlling the whole process, constraint analysis, among others. This paper focuses on three house-building projects that had high levels of customisation and how the customisation process was managed.

KEY WORDS

Customisation, value, business strategy, housing.

INTRODUCTION

The increasing diversity of dwellers lifestyles and requirements demand changes in the house building industry. The adoption of customisation strategies by construction firms will increase product value. For that reason the concept of mass customisation and related principles can potentially provide a conceptual basis for implementing such strategies.

Stan Davis coined the term mass customisation (MC) in 1987 in his classical book *Future Perfect* (Kumar et al. 2007). Since then, the term has been used in numerous

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papers of several areas such as operations, marketing and product design, yet without a single definition. Despite the several definitions presented in the literature, Kumar (2004) identified two key elements of this concept: (a) the product delivered to customer is close to what he/she wants (i.e., has a high level of customisation) and (b) the price of such product is not proportional to the level of customisation provided (i.e., ideally the product should have a price similar to a standardized product).

As mass customisation aspires to achieve a high degree of product variety at a cost similar to mass production, it is considered to be an oxymoron or a paradox by many authors such as Selladurai (2004), Hart (1995), Blecker and Abdelkaf (2006) and Kumar et al. (2007). It could be said that mass customisation seeks to combine the benefits of two competitive criteria: cost and differentiation. Such an idea is consistent with Prasad et al. (2001) who stated that nowadays, due to increasing pressure and competition, it has become necessary for firms to compete in two or more competitive criteria.

Despite that, the adoption of customisation strategies based on the MC concept in the housing construction industry is still limited. This may be due to the challenge of achieving a proper balance between fulfilling customers requirements by increasing product diversity, whilst maintaining process efficiency. This article presents the case study of a construction firm in the city of Fortaleza, in the Northeast of Brazil, which has been heavily involved in the Lean Construction movement since 2004. The article focuses on the implementation of a customisation process and the practices that have enabled the firm to cope with the two apparently opposing ideas, underlying the mass customisation concept: product variety and process efficiency. This article aims to illustrate how those practices relate to lean principles, and how these in turn can support customisation goals. It is worth mentioning that although price is an important component of the mass customisation process, it is not addressed in this paper which is concerned with the practices used to manage the customisation process.

CASE DESCRIPTION

CASE STUDY

The study was carried out in a medium-sized construction firm in the city of Fortaleza, Northeastern Brazil. The firm has been involved with different programs related to quality management and innovation, and its quality management system is ISO 9000 certified. Since 2004 the firm has been adopting the lean philosophy, principles and tools as reported in several papers (Kemmer et al., 2006, 2007, 2008 and 2009). This paper describes a set of practices created by the firm and adopted in the development of three building projects described in Table 1.

Table 1: Building Projects

Housing project	Building Project 1	Building Project 2	Building Project 3
Total area	11.600 sq meters	14.836 sq meters	34.203 sq meters
Features	2 underground floor ground floor and mezzanine	2 underground floor ground floor and mezzanine	2 underground floor ground floor and mezzanine
Number of buildings	1	1	2
Number of floors	22 floor	22 (22th floor with duplex units)	22 (22th floor with duplex units)
Housing unit per floor	1	2	2 towers (A and B)
Area of housing unit	317sq meters	217 sq meters	259 sq meters
Delivery date	Concluded (July/2007)	Concluded (Dec/2008)	December/2010

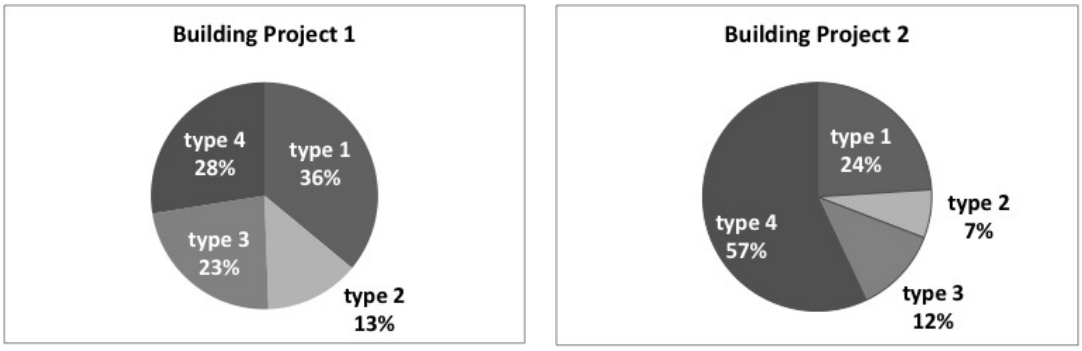
CUSTOMISATION

Customisation of housing units carried out by the case study firm can be broadly divided in four types according to the degree of design change of housing units (Table 2). Type 1 involves the selection of floor finishes and electrical fittings from a set of options offered by the firm. Other types of customisation usually involve interior architects hired by the customers, which make the customisation process even more complicated. Such designs are considered type 3 customisations if they set out changes in the housing unit interior layout, but do not alter finishing materials or fixtures. Designs that allow for alterations in finishing materials and fixture specifications, but no layout changes are considered type 2 customisations. Finally, designs combining changes of layout, finishing materials or fixtures are categorized as type 4 customisations.

Table 2: Types of customisation

Customisation	Description
Type 1	Selection of floor finishes and electrical fittings by the customer
Type 2	Modifications of specifications of finishing materials and electrical and plumbing fixtures (no modifications of layout)
Type 3	Modifications of layout (no modifications of finishing materials nor fixtures)
Type 4	Modifications of layout and specifications of finishing materials

Figure 1 shows the types of customisation of housing units undertaken in four buildings. More than half of the housing units of all building projects had had a customisation type 2, 3 or 4. Due to customer demand for these types of customisation, the firm has been developing and improving practices that support such customisations. Such practices and improvements are particularly important for supporting these customisations, especially type 4, as this is the most complex of all four types and can be harmful to the processes of the firm if it is not properly managed.



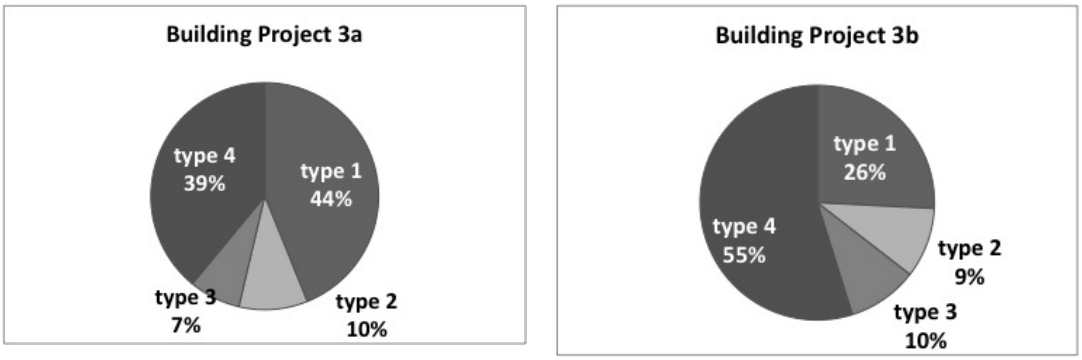


Figure 1: Evolution of customisation in the firm

Figure 2 shows the processing of customisation types 1, 2, 3 and 4 and the main activities involved. The customisation process can be broadly divided in two phases: management of customisation designs or registration of customer decision, carried out at the office (upper box of figure 2) and construction of customised units, undertaken by the production area (lower box of figure 2). The customisation process is initiated prior to the construction of the first building floor containing housing units by sending a kit to each customer informing them of the possibility of customising his/her unit. The kits contain a letter presenting the scope and limits of the customisation offered by the firm, a set of floor plans and elevations of the housing unit and a document listing the specifications of all finishing materials, plumbing and electrical fittings with images. The letters are sent in batches, according to the master plan. The letter also informs the customer of the deadline for making his/her choices. Each customer has 75 days to decide after the letter has been sent. From this point on, two paths can be taken depending on the type of customisation selected. If the customer decides to have his/her housing design developed by an interior designer (i.e., customisation type 2, 3 and 4), a set of activities take place such as analysis of the design provided and generation of a budget, which is presented to the customer for approval. If the design relocates or modifies service systems (i.e., electric, communication, air conditioning and plumbing systems), it is sent to the firm responsible for those designs in order to have them tailored accordingly (Figure 2). If the customer does not want to have his/her housing unit design developed by an interior designer (i.e., customisation type 1), he/she is only required to select a floor finishings and electrical fittings model. Figure 1 clearly shows the greater complexity involved in customisation types 2, 3 and 4 as they involve several activities and points of customer-firm interaction in comparison to customisation type 1.

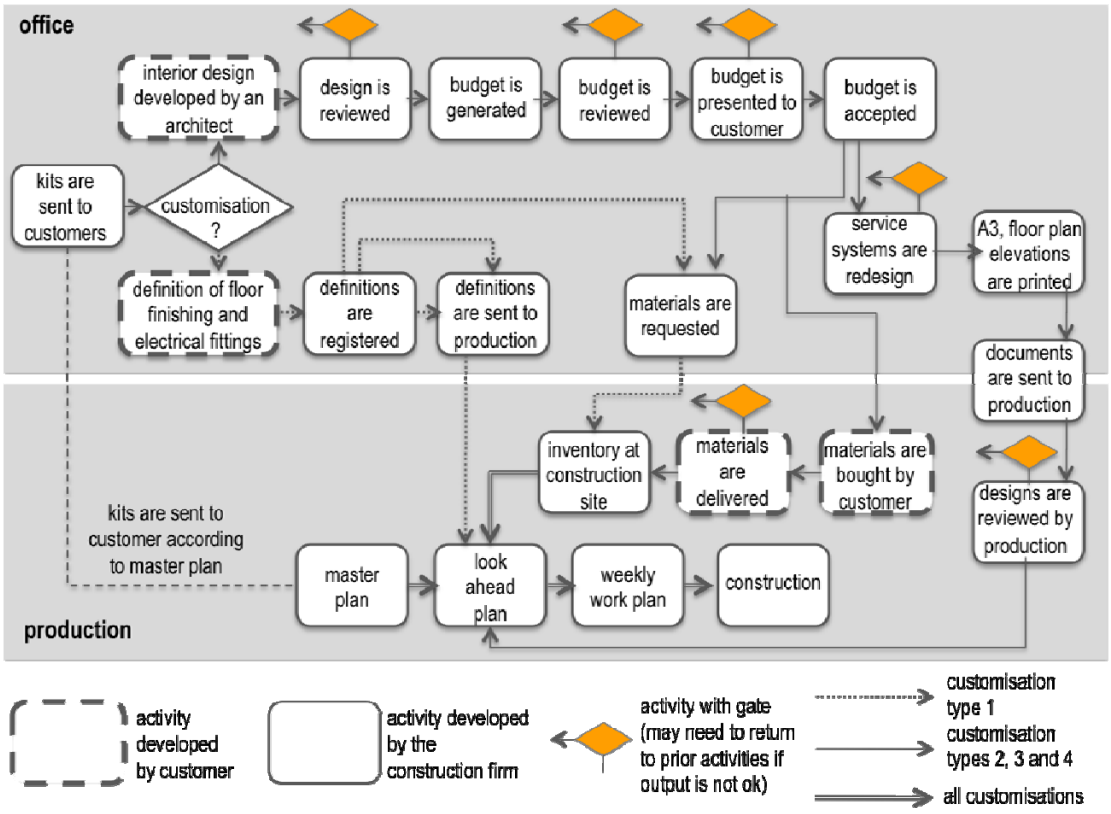


Figure 2: Customisation process

MANAGING A CUSTOMISATION PROCESS – MAIN POINTS

The customisation process in the firm has been developed and improved according to lean principles as presented in Table 3. This article will demonstrate how these principles relate to the customisation process of housing units and how they help to manage the alterations demanded by customers.

It is worth mentioning that while in Building Project 1, the letters were sent in a unique batch; all at one time, in Building Project 2 the dispatch batches were issued two floors at a time.

Sending letters to customers in small batches was intended to smooth and level the processing of demand created by the customisations in the sectors responsible for its management. In other words, if a large batch of letters were sent to customers all at once, a lot of projects would have to be managed at the same time by the quality and technical areas, which would certainly create an overload (muri) in the managerial system of the firm.

The customisation process begins with the letter to the customer. Attached to the letter are details of the plans and standard material specifications used by the firm (these are sent by hard copy and by digital file). The letter also contains related plans which must be returned to the technical department and guidance defining the limits of the customisation process.

The purpose of the letter is to maximise transparency and to avoid activities that do not add value, such as failures during the process caused by omissions and errors which interrupt the continuous flow of customisation.

Table 3: Relation between Firm Practices and Lean Principles

Principles	Brief description of each practice
Transparency/ value	Kits for the customer
Transparency/ value	Showroom with finishings
Transparency	Tools for easing the transmission of customisation requirements to all areas of the firm (e.g. A3 projects for production)
Reducing non-value adding activities/ Transparency	Standardization of customisation activities and tools
Reducing non-value adding activities	Letter for the customers with check list requirements
Reducing uncertainty	Use of hierarchical production planning and control system
Use of small batch sizes	Kits sent to customers in small batches (smooth flow in the quality and technical areas)
Increase flexibility	Use of cells of production with groups of activities (like ceramic tiling and gypsum work packages)
Systemic view	Kits sent to customer according the master plan (line of balance – LOB)

To increase the transparency of the information provided, as well as facilitating and speeding up the customer decision process with regard to the choices about materials used, a showroom was created displaying all the fittings, finishings and specifications (Figure 3).

This showroom displays the ceramic floor and tiling options offered by the firm, as well as the bath and toilet fittings and the electrical fittings. It is worth to highlighting the transparency that this idea brings to the process; the descriptive manual shows only the material specifications in written form, where the customer cannot visualize what will be applied in the apartment. With the showroom, customers can easily choose from the models available or customise according to their individual requirements. All the information provided to customers during this initial phase aims to make the customisation process more transparent and less susceptible to mistakes, so that the flow can be continuous, avoiding delays to the process.

After the design changes have been defined and the correspondent budgets approved, the firm sends the customisation plans to the building site. In this phase of the process, special care must be taken sending the projects and the information to the building site.

Due to the high number of project specifications, several A3 plans are specially formatted and laminated, so that they can be available at the work place for the crew and also for the site manager. Figure 4 below shows the huge number of plans that are wall mounted in the main entrance of the customised housing unit.

Figure 3: Showroom with fittings and finishings.

Figure 4: Production plans at the work place.

For each housing unit a display board showing all the plans for that unit is assembled, helping the transparency of the process and the autonomy of the workers. The production managers and the crew can consult these projects at all times at the place where the activities are being carried out.

It is possible to see from Figure 4 that there is also a color table. This table objectively presents definitions about the material specifications used in each sector of the apartment (Figure 5).

APARTMENT	SECTOR	ITEM	DEFINITION	OBSERVATION	MATERIAL SPECIFICATION
1202	SOCIAL BATHROOM FLOOR	1	CUSTOMISED	SPECIFY THE MATERIAL ON THE NEXT CELL	GRANITE STONE JUPARANÁ GOLD
1202	SOCIAL BATHROOM WALL		CUSTOMISED	SPECIFY THE MATERIAL ON THE NEXT CELL	WHITE PAINTING
1202	MASTER BATHROOM JACUZZI	2	JACUZZI-YOUNG COLLECTION-AUTHENTIC	STANDARD MODEL	
1202	ELECTRICAL FITTINGS	3	NOT APPLICABLE	CUSTOMER RESPONSIBILITY AFTER DELIVERY	

Figure 5: Material specifications for each sector of the apartment.

According to Figure 5 it is possible to consult the customisation for each sector of the apartment. This sheet presents the definitions about ceramic flooring and tiling and finishes such as bathroom and electrical fittings.

Figure 5 shows the use of colors to increase transparency and to easily communicate the necessary information, resulting in a visual control of the design changes. Yellow (item 1) demonstrates the customisation, followed by its specification, green (item 2) shows that the chosen material is the pattern provided by the company and red (item 3) points out that no material will be applied in that particular area; the customer will install the fittings and finishes after the unit has been delivered.

CONCLUSIONS

Increasing customer value should be an essential feature of lean systems. Yet, a major challenge is to increase product value whilst maintaining process efficiency. This paper aimed to present the customisation process and practices developed by a construction firm. A synthesis of the firm's practices and their relation to lean principles and customisation goals is shown in Figure 6. Most practices related to lean principles contribute mainly to the *maintain process efficiency* goal. Yet, some practices related to the transparency principle such as *showroom with materials finishing and fixtures* and *kit for customer* also contribute to increasing customer value and maintaining process efficiency (Figure 6). The majority of practices observed seem to be related to the office area (i.e., the management of customisation designs) and to the relationship between the two areas involved in the customisation process. Still few practices strictly related to the production area were observed: *activities in LOB in small batches, use of cell of production with groups of activities* and *use of hierarchical production planning and control system*. For that reason, it appears that the firm's principle aim was to create a smooth and level flow for processing the customisation designs, which would be reflected in the production activities. An excellent example of this is *sending kits to customer in small batches*, which can facilitate material procurement, production, and checking materials at the construction site to also be carried out in small batches.

There also seem to be differences from lean principles supporting office and production practices (Figure 6). On the one hand, office practices seemed to be especially supported by the *increase transparency* principle. On the other hand, the *reduce uncertainty* and *increase output flexibility* principles appeared to be more related to production practices. The *use of cell of production with groups of activities* is especially important to increase output flexibility. Practices related to the *reduce*

uncertainty principle are important for *reducing the share of non-value adding activities* by anticipating and solving problems that could increase such activities in office and production processes. For instance, the *use of hierarchical production planning and control system* avoids delays on the production line caused by customers delivering finishing materials to the construction site. This case study has indicated that customisation can be supported by lean principles, especially for maintaining process efficiency. Interestingly, such principles were particularly adopted for office activities, i.e., management of the customisation designs and their processing prior to their delivery to the production area.

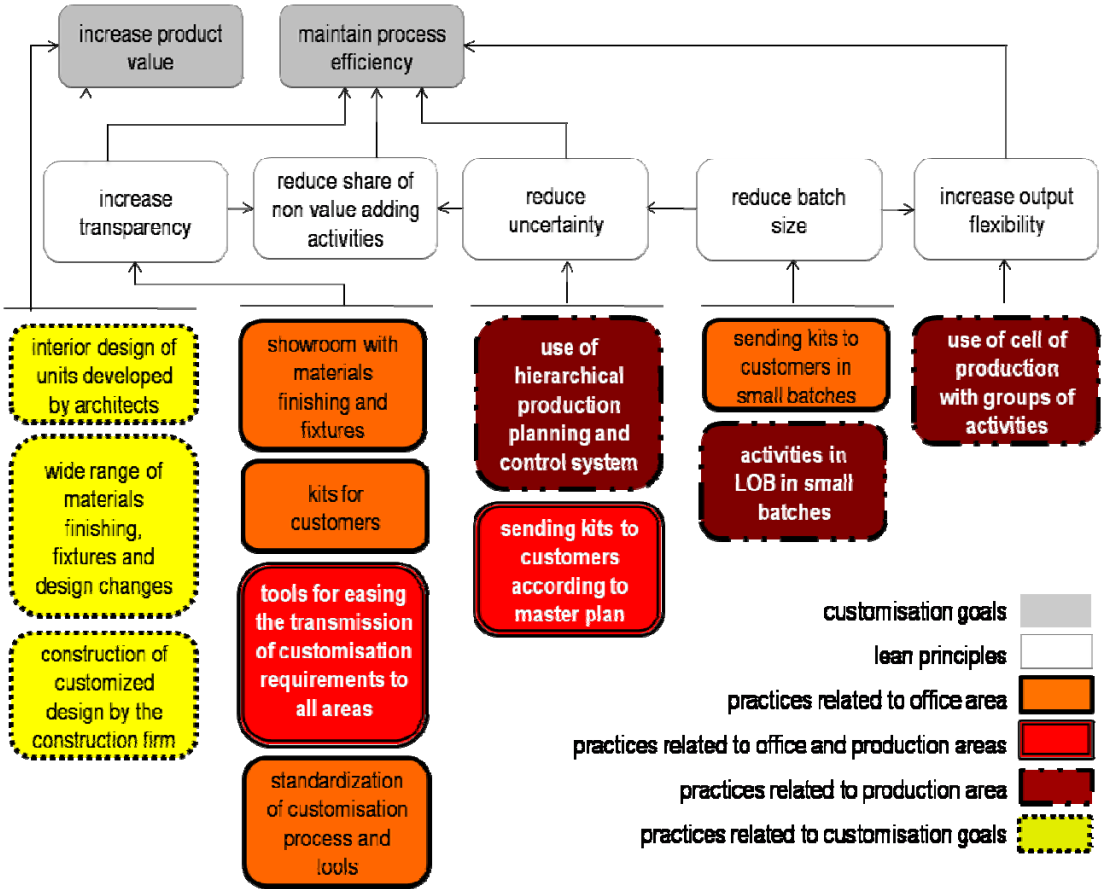


Figure 6: Practices, principles and goals of customisation

ACKNOWLEDGMENTS

Authors would like to thank Construtora C. Rolim Engenharia Ltda. for allowing this study to be published.

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