AN OVERVIEW OF THE CUSTOMISATION STRATEGIES DEVELOPED BY FOUR ORGANISATIONS OF THE HOUSE-BUILDING SECTOR

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ABSTRACT

Mass customisation (MC) refers to the provision of customised products while striving to maintain the efficiencies of mass-production. Such concept has emerged in the manufacturing sector but can also be deployed by the construction industry to add more value to products.

This paper analysis the customisation strategies developed by four organisations of the house-building sector using a conceptual framework. Such organisations have differences in terms of the scale of the product provided, the amount of years they have been operating, and the stage in the product development process that they are at. Two organisations are located in Brazil and the other two are located in the UK. This paper aims to explore how customisation strategies based on the MC approach can be pursued under different organisational contexts. An underlying proposition of this paper is that MC can add value to housing products and that it can be adapted and tailored to be used in different organisational contexts. The case studies with the four organisations aim to illustrate that. Such studies also provide an initial step in exploring how MC can be tailored to particular organisational contexts within the construction industry.

KEYWORDS

Customisation, housing, decision making, strategies, design.

INTRODUCTION

Mass customisation (MC) refers to the strategy of customising goods and services with cost and delivery period similar to standard products. It can be viewed as a strategy, which seeks to simultaneously compete in two generic strategies – cost and differentiation – proposed by Porter (2004). In order to simultaneously achieve customisation and economies of scale, it is necessary to coordinate strategic decisions concerning the whole value chain. As noted by Da Silveira et al. (2001), MC is a systemic concept and its success depends on the readiness and willingness of suppliers, distributors, manufacturers, and retailers to cope with it.

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Despite the possible contribution of MC and related principles in the housing field, its full potential has been little explored so far. Most studies (e.g., Barlow 1999, Patchell 2002, Gann 1996, Barlow et al. 2003) look at the characteristics of the house-building sector in distinct countries and whether they constrain or enable the adoption of MC. Consequently, such studies provide limited information on how MC can be adopted by individual organisations in developing customisation strategies.

Seeking to address this problem, this paper presents an overview of the customisation strategies developed by four organisations of the house-building sector using a conceptual framework. Such analysis aims to illustrate how MC can be tailored and deployed by different organisations of the house-building sector. It also provides empirical evidence that MC can be pursued by different organisations and is applicable to different kind of products (housing components, dwelling units, and residential schemes). Such analysis and the framework have been developed as part of the Ph.D. thesis of the first author.

DECISIONS INVOLVED IN DEFINING A CUSTOMISATION STRATEGY

Outlining the solution space is a core decision that should be made in defining a customisation strategy. A solution space defines what an organisation will and will not offer in terms of customisation (Salvador et al. 2009). It refers to the scope of choice made available to clients while they are co-designing their configuration of preference (Kumar 2004). In order to devise a solution space, it is necessary to analyse the client idiosyncratic requirements and identify the product attributes along which clients' requirements diverge (Salvador et al. 2009). Besides identifying those attributes, an organisation should ensure that it has the required capabilities to provide such customisation efficiently and profitably (MacCarthy and Brabazon 2003).

After defining the solution space, it is necessary to properly communicate it to clients. Different interfaces such as choice menu and configuration toolkits can be used to present the solution space. Such interfaces enable clients to design individualized products by choosing from a set of attributes, components, prices, and delivery options (Slywortzky 2001). Usually, a sequence of choices needs to be done in order to create a product variant that meet a client specific requirements.

The solution space outlined also needs be to adequately translated into the product design. In many cases, a modular architecture is used as it enables different product variants to be created using a limited number of modules. As argued by Pine (1993), by using modular components, economies of scale are gained at a components' level and economies of scope are gained by using those components in several product variants.

Finally, production and supply chain should be able to efficiently provide the product variants. A necessary condition for this is to have a well-defined solution. By clearly defining what can and cannot be customised, an organisation can plan processes that are able to provide such customisation efficiently. Cellular processes, which entail a cellularity consistent with the product modularity, often in one-to-one correspondence, can be used (Piller and Kumar 2006). Postponement (or delayed product differentiation) is another approach that can be adopted for reducing the delivery time in providing the product variants.

RESEARCH METHOD

RESEARCH PROCESS

This investigation adopts a constructive research (or design science) approach, which is concerned with the devising and evaluation of man-made artefacts aiming to resolve real-world problems. It was divided in tree sequential stages (Figure 1). Each stage involved key steps of a constructive research approach proposed by Kasanen et al. (1993). As shown in Figure 1, four case studies (CS1, CS2, CS3, and CS4) were carried out and used in different steps during the three stages.

	Case studies used in the steps in each stage		
Steps	Stage A	Stage B	Stage C
1. Find a problem		----	----
2. Obtain an understanding	CS1	----	----
3. Collect case study data*	CS1 and CS2	CS3 and CS4	
4. Develop the solution, i.e., the framework	CS1 and CS2	CS1, CS2, CS3, and CS4	CS1, CS2, CS3, and CS4
5. Assess the usefulness of the solution	CS2	CS4	CS3
6. Assess the theoretical contribution of the solution			

* New step, not originally proposed by Kasanen et al. (1993)

Figure 1: Case studies in the research processes (Rocha 2011)

The first and second steps, which were carried out only in stage A, involved the definition and understanding of the research problem (figure 1). Such step was followed by the data collection of the case studies, which provided empirical data for the solution development. The initial activity of such step involved the devising of a preliminary version of the framework, mainly based on concepts available in the literature. Such framework was then applied, i.e. used to describe and analyse the customisation strategies based on the data gathered in the third step. The application of a solution in a particular context is termed instantiations and is necessary to demonstrate the feasibility and effectiveness of the conceptual elements that the solution contains (March and Smith 1995). A reflection concerning the framework, the instantiations, and how they portrayed the customisation strategies was carried out. The preliminary version of the framework was then refined, taking into account the results of such reflection and initiating a new cycle of solution development. In each stage, several cycles were carried out until reaching a version of the framework that could provide a potentially useful instantiation.

The usefulness of the framework (fifth step) was assessed by discussing the critical analysis of such instantiations with the case studies' partners. Actions that the partners realised or planned to undertake based on those results were registered as they provide evidence of the usefulness of the framework. The sixth step encompassed an assessment of the framework from a theoretical viewpoint.

OVERVIEW OF THE CASE STUDIES

Case study 1 (CS1) was carried out in a recycling company located in Brazil that was initiating the design of pre-fabricated floor tiles. Company 1 envisioned two market segments for this product: homeowners, which were building or refurbishing their homes and contractors. Case study 2 (CS2) was carried out in a contractor based in Brazil that designs and builds apartment buildings for high-end clients. Company 2 had been operating for more eight years and had developed more than eight residential projects.

Case study 3 (CS3) was carried out in a contractor based in the UK that develops and builds residential schemes for social housing. Company 3 had recently developed a prefabricated pods system. Each pod, which entails a set of rooms, is produced at the factory and is delivery fully fitted at the construction site. Once the pods are craned onto the foundations, the external cladding and roofing are built, completing the dwelling units. Case study 4 (CS4) was carried out in a consortium of four registered providers[4] based in the UK. The goal of the consortium was to increase efficiencies by collaborating and sharing a set of consultants and contractors for developing residential schemes. In addition to that, the consortium had also defined a set of dwelling designs to be used when developing a scheme.

RESULTS

A CONCEPTUAL FRAMEWORK FOR DEFINING CUSTOMISATION STRATEGIES

The framework entails ten decision categories (Figure 2). The core decision categories are the starting point for outlining a customisation strategy. They should be defined prior defining the other categories. The organisation and hierarchy of the decision categories showed in Figure 2 were only reached at the end of the research process. In terms of the framework development, at the end of stage A only the following categories had been devised: *solution spaces*, *customisation units*, *types of customisation*, *visualisation approaches* and an early version of *production sequence*. *Classes of items* and *configurations sequence* were developed in stage B, whereas *modules*, *module interfaces*, and *module combinations* were developed at stage C. In stages B and C, categories previously defined were also refined.

Core categories: customisation units, solution space, and classes of items

Each customisation unit is formed by a customisable attribute and the range of items offered for such attribute. For example, for the colour attribute, three items may be offered (red, blue, and green), configuring a customisation unit. Besides outlining the items in a customisation unit, it is important to identify the nature of change embedded in them, which is defined by *classes of items*. A customisation unit can entail categorical, ordinal, discrete, and metric items. Most customisation strategies involve more than one customisation unit. In this way, it is also necessary to define *solution spaces*, which outlines how the customisation units are combined. Generally, a product variant is defined when an item in each customisation unit forming a solution space (SS) is selected.

[4] Registered providers are responsible for the identification of social housing demands and for the development of residential schemes that meet those demands. They act as clients, commissioning schemes that are developed and produced by contractors and consultants.

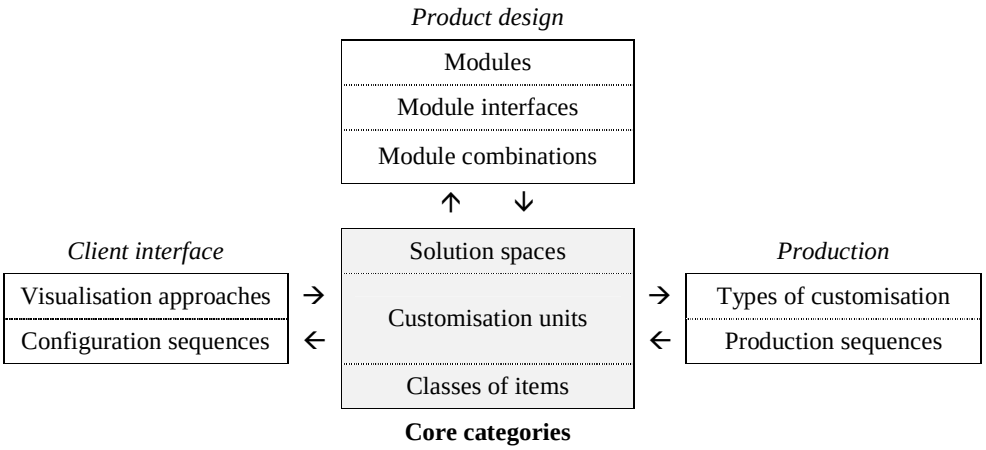

Figure 2: Conceptual framework (Rocha 2011)

Types of customisation and production sequences

Types of customisation is concerned with the activity involved in providing a customisation. It is argued that each customisation unit employs a particular activity. Such category builds upon the taxonomy proposed by Da Silveira et al. (2001). Customisation at design, fabrication, and installation are customisations in the physical part of a product. Customisation at delivery, distribution, packaging, labelling, and retailing are customisations in services surrounding the physical part of a product. Customisation at use and segmented standardisation are not exclusively related to goods or services. Customisation at use occurs when a standard, but customisable product is provided, and it is customised by the user. Segmented standardisation occurs when a set of standard products are offered based on an anticipation of clients orders, although not directly catered to them (Lampel and Mintzberg 1996).

Production sequences is concerned with the sequence of activities performed by an organisation to provide a product variant. Particularly, it is concerned with the activities that are influenced by any of the customisation units forming the solution space (figure 1). An activity is defined as influenced if it requires information about the item selected in a customisation unit to be carried out. As the items selected are usually stated in a client order, influenced activities can usually be performed only after a client order is received. In general, production sequences with few activities influenced by customisation are simpler than production sequences with several activities influenced by customisation.

Visualisation approaches and configuration sequences

Visualisation approaches defines how a customisation unit is presented. Based on Gilmore and Pine (1997), it is suggested that a customisation can be displayed using three approaches: (i) collaborative, clients and the organisation are aware that a customisation is happening and explicitly engage in defining the product variants; (b) transparent, an organisation defines the items in the customisation units based on the clients specific requirements but without requiring their direct input; and (c) do-it-yourself (DIY): an organisation offers a standardised product that is later customised by clients.

Configuration sequences outlines the chain of decisions that should be followed in defining the items in the customisation units forming a solution space. Decision concerning the items in some customisation units might need to precede the decision concerning others. Other decisions might not need to follow any particular order and can be done in parallel.

Modules, module combinations, and module interfaces

Modules are product parts that are combined in different ways for creating product variants. Modules can be organised around primary functions (functions performed by people such as reading, sitting, sleeping, and so on) or secondary functions (functions accomplished by the building such as load bearing, enclosure). Primary functions are performed by people in the spatial voids of a building, whereas secondary functions are performed by the physical mass of a building.

Module combinations are concerned with the modules used for creating each product variant offered in a solution space. Outlining the modules combinations is particularly important because it provides an overview of the reuse of modules within and across product variants. Reusing modules simplifies the production process as several product variants can be created using a limited number of parts.

Modules interfaces is concerned with the relationship among interacting modules. An interface is defined as loosely coupled when a module can be interchangeably used (without any physical alteration) across the different module combinations it is used in. Conversely, an interface is defined as tightly coupled when a module cannot be interchangeably used and requires physical alterations to be used across different combinations.

INSTANTIATIONS

This section presents the four instantiations (figure 3) that were created by analysing the customisation strategies in the case studies according to the ten decision categories.

	Case study 1	**Case study 2**	**Case study 3**	**Case study 4**
Customisation units	C1 – off-the shelf mixes C2 – promotion modes C3 – package size C4 – colours C5 – shapes	C1 – floor plans per block C2 – colour for plugs and switches C3 – floor tiles for dry areas C4 – floor plans C5 – customisation of layout and specifications	C1 – external cladding C2 – roofing C3 – external windows and doors C4 – kitchen fit-outs C5 – bathroom fit-outs C6 – dwelling types	C1 – dwelling designs to be used in a particular location in the UK that has specific requirements for social housing C2 – dwelling designs to be used elsewhere
Solution spaces	SSA: C2, C3, C4, and C5 SSB: C1, C2 and C3	SSA: C1 SSB: C4 SSC: C3 and C4 SSD: C1, C2 and C5	SSA: C1, C2, C3, C4, C5, and C6	SSA: C1 SSB: C2

Figure 3: Customisation units and solution spaces in the studies (Rocha 2011)

Case study 1

Company 1 plans to use five customisation units for the floor tiles (Figure 3). All customisation units, except for C3, have categorical items since they are non-quantifiable and do not have an intrinsic ordering. C3 is a customisation at packaging with and its items have an intrinsic ordering: there is a small (offered to homeowners)

and a large package size (offered to contractors). C4 and C5 are customisation at fabrication since they involve the shaping and pigmenting of tiles. C1 is a segmented standardisation since pre-defined mixes are offered in anticipation to clients' orders. C2 is a customisation at retailing: tiles will be advertised differently to the two market segments.

The customisation units are combined in two solution spaces, each of them targeted to one market segment (Figure 3). Concerning the configuration sequence, Company 1 will first define the items to be used in C2 and C3 depending on the client at hand. Hence, those customisation units are displayed using a transparent approach. If the client is a contractor, C4 and C5 will be offered. Alternatively, if the client is a householder, C1 will be offered.

Company 1 was in an early stage in the product development process. Consequently, there was limited information on the design of the tiles and on the production process. As a result, it was not possible to apply *production sequence* and the decision categories related to the product architecture (modules, module combinations, and module interfaces).

Case study 2

Company 2 uses five customisation units for the apartments (Figure 3). C1 and C4 have ordinal items since the different floor plans can be organised in terms of the number of bedrooms. C1 is a segmented standardisation as each block has a different floor plan, and thus, the floor plan options are offered prior to client orders. Differently, C4 is a customisation at fabrication since different layouts can be built into the apartment based on a client order. C2 and C3 have categorical items as they have no numerical meaning or intrinsic ordering. C2 is a customisation at installation since the plugs and switches are simply screw onto the walls, whereas C3 is a customisation at the fabrication stage. In C5, clients can have the interior of the apartment developed by interior designers. This enables an unlimited number of items to be created because each apartment has a truly bespoke design.

The customisation units are combined in four solution spaces (Figure 3). Different solution spaces are used depending on the area of the apartments, which changes from project to project. SSD provides the largest degree of customisation since it entails C5. It is usually offered in projects, which have apartments with an area of 201 m2 or more. Off all solution spaces, SSD has the production sequence with the largest number of activities influenced by customisation due to C5. As C5 enables clients to customise all the interior of the apartment (except for elements such as the structural system and external enclosures), the majority of activities related to the apartment construction are influenced by customisation. SSC is offered in projects whose apartments area range between 101 and 200 m2. SSA and SSB are used in projects that have apartments with less than 100 m2. The production sequences for SSA, SSB, and SSC have fewer activities influenced by customisation than the production sequence for SSD since the customisation in those solution spaces is narrower.

In all solution spaces, all customisation units are displayed using a collaborative approach since clients directly select the desired items. C3 and C2 relate to independent attributes of the product and hence the selection of items does not have any interdependence in SSC. For SSD, C1 is offered first since the apartment plan is defined at the moment the apartment is purchased. C2, C3, and C5 are only offered later, after the building construction has started.

In terms of the product architecture, modules are organised in terms of primary functions since the different floor plans in C1 and C4 are provided by swapping some rooms while keeping most of the apartment layout unchanged. Each of those rooms can be viewed as a module since they are combined in different ways to provide the different floor plans. In most projects, some modules are reused across the different floor plans. Yet, there are physical parts (for example, a wall) that belong to two or more modules, hampering the production of modules as independent entities. This also hinders the interchangeable use of modules since physical changes are required for using the modules across the different combinations. For those reasons, the modules interfaces are defined as tightly coupled.

Case study 3

In case study 3, the product variants are residential schemes that are designed using a set of five dwelling types. Clients can define the mix of dwellings to be used and also customise their specifications (Figure 3). C6 is a customisation at fabrication since different dwelling types are provided based on a number of pre-defined designs. It has discrete items since clients can select different quantities of each of the five dwelling types. C4 and C5 have categorical items and are customisations at fabrication. Company 3 had not defined the scope of the customisation in C1, C2, and C3. In this way, it was not possible to define range of items contained in them or the types of customisation involved. All customisation units are presented using a collaborative approach as clients directly select the items in them. They are combined in a single solution space and are all offered to clients at the same time. This creates configuration problems because clients may specify clusters of dwellings that have different specifications.

The dwelling units are created by combining two, three, or four pods out of a set of ten pods. Hence, the pods can be viewed as modules. The product architecture is organised around primary functions since each pod entails a set of rooms. Each module has a specific set of physical parts assigned to it, enabling modules to be produced as independent entities. Some modules are reused across the different combinations. Modules that are used in more than one combination can be interchangeably used across them without any physical alteration. Hence, the modules interface are defined as loosely coupled. In terms of the production sequences, it was not possible to identify the activities influenced by customisation because the range of items offered in C1, C2, and C3 was not clearly defined.

Case study 4

In case study 4, the product variants are residential schemes, which are designed using a set of standard dwelling types. C1 and C2 are customisations at fabrication since schemes are built using a set of previously defined designs (Figure 3). They also have discrete items, meaning that the registered providers can specify different amount of each design to be used in a scheme. Each of the customisation units in used is one solution space and the solution space to be used will depend on the location of the scheme at hand. This means that the location of the scheme should be defined first, prior defining the customisation unit to be used. The floor plans for each dwelling in C1 and C2 contain the layout and dimensions of the rooms, and suggestions for position of furniture, fixtures, and doors and windows. Yet, they do not contain any specification since it is assumed that the dwellings can be built using different construction methods, finishing, and fixtures. Also, they do not provide

details on the roofing and facades to allow the architectural practices to design bespoke streetscapes.

Each of the dwellings in C1 and C2 can be viewed as a module since they are mixed and matched to create the product variants. The floor plans outline the spatial voids forming the dwellings, suggesting that this product architecture is organised around primary functions. Yet, it they do not provide information on the relationship between the primary functions and the physical mass since the construction method and specifications are not defined. This hinders the assessment of the interface among the modules. Also, the modules combinations and the reuse of modules could not be assessed since an endless number of product variants can be created: each architectural practice can mix and match the different dwelling designs as necessary in developing a scheme. *Production sequence* does not apply to the customisation strategy developed in this case study because different construction methods and contractors are assigned for each scheme.

CONCLUSIONS

This paper has presented an overview of customisation strategies developed by four organisations of the house-building sector. Such organisations have different roles, provide different products, and are at different stages of the product development process. Nonetheless, all four strategies could be analysed using the framework, which adapts and refines key concepts related to MC. This indicates that MC can be tailored to different organisational contexts and can be adopted by different organisations of the house-building sector.

Clearly, some decision categories cannot be applied in every organisational context as suggested by the instantiations. This may happen if an organisation is in an early stage of the product development process (as in case study 1) and information is not yet available. There might also be situations in which a category is not applicable because of the particular business model (for example, in case study 4). Nonetheless, the core categories, which provide the basis for the other categories to be defined, could be applied in all four case studies. Difficulties in analysing those categories indicate problems in the definition of the scope of the customisation. On the one hand, this precludes the analysis of other decision categories as observed in case study 3. On the other hand, it indicates an opportunity for the organisation to improve the customisation strategy.

The framework also provides a common ground to describe and analyse customisation strategies developed in the house-building sector. To the best of our knowledge, a readily applicable structure for analysing and comparing customisation strategies in such sector had not yet been proposed. Subsequent research initiatives will involve the application of the framework in devising customisation strategies, rather than analysing existing strategies. Such initiatives will investigate if the framework can be adopted by practitioners in developing customisation strategies.

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