Architectural Approaches to Housing Customization

Introducing the Inhabitant-Driven Customization Approach and the MyChanges Tool

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DOI
10.1108/ARCH-05-2021-0124

Publication date
2022

Document Version
Accepted author manuscript

Published in
Archnet-IJAR

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Structured Abstract

Purpose

Customization is a paradox in architecture, providing necessary modernization for buildings but potentially damaging their architectural integrity. In this paper we introduce the Inhabitant-Driven Customization approach for avoiding this paradox; this approach lets inhabitants design the customization from options created by architects that safeguard architectural rules. As a first implementation of the Inhabitant-Driven Customization approach the MyChanges tool is presented. We assess whether the approach avoids the customization paradox by a qualitative stakeholder evaluation of the MyChanges tool and by a comparison of the Inhabitant-Driven Customization approach with existing approaches to housing customization.

Design/methodology/approach

MyChanges is a shape grammar-based design tool developed to enable inhabitants of the Álvaro Siza Vieira Malagueira housing complex to customize their houses in accordance with the architectural language of the complex**.** In this study we qualitatively evaluated MyChanges with architects and other professional stakeholders. MyChanges is used in this paper to assess if the Inhabitant-Driven Customization approach avoids the paradox of customization. The initial reception of MyChanges produced diverging outcomes, suggesting that Inhabitant-Driven Customization is also unable to avoid the customization paradox. For analyzing this possibility further, this paper describes the main existing approaches to housing customization, including the Inhabitant-Driven Customization approach, formulates nine conditions for these approaches, and provides a qualitative comparative assessment of the approaches.

Findings

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The customization paradox is demonstrated in the outcomes of the interviews with professional stakeholders on the MyChanges customization tool for the Malagueira housing complex.

An argument is given that makes plausible that the Inhabitant-Driven Customization approach avoids the customization paradox by creating a co-design process in which inhabitants and architects alternately shape customization.

Originality

The originality of this paper lies in the introduction and discussion of the paradox of customization in housing. The paper identifies the conditions advanced in architecture for assessing housing customization approaches. Additionally, we propose a new customization approach and a design tool that to a large extent fulfills those conditions and avoids the customization paradox.

Keywords: customization; housing; MyChanges; shape grammar; customization conditions; architecture.

1 Introduction

Customization is a paradox in architecture: it preserves buildings, since inhabitants engage with their houses and modernize them, but may also damage buildings when it is performed without respecting the architectural design principles. In architecture this paradox leads to heated debate in the case of housing with high architectural value, such as Le Corbusier's Quartier Modern Frugès and Unité d'Habitation, Habitat 67 by Moshe Safdie, and the Malagueira housing complex by Álvaro Siza Vieira. Customizing such housing in a way that maintains the original structure may reflect architectonic care, in line with the Venice Charter for conservation and restauration, but limits the possibilities for upgrading it to modern standards and to personal preferences. The more participatory and open approaches of the 1960s and 1970s, in turn, enable inhabitants to adapt housing more freely yet may easily

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damage the integrity[1] of the original architectonic design. Even cases of incremental design as the ones of Elemental office in Chile, suffer from this paradox. On the one hand the Quinta Monroy project promotes later transformations by inhabitants and includes customization principles that assure the protection of the architecture and quality of the neighborhood. On the other hand some of such transformations were consider to have broken the rules and negatively impact the architecture quality of the neighborhood (Fernandes, 2015). The same situation occurred in the Villa Verde project where inhabitants also transgressed the extension rules provided by Elemental office causing Brien, Carrasco and Dovey to question "what will stop (…) additions from escalating into a 'slum' " (2020, p. 356).

This paradox in housing customization may be unpacked as a conflict in which the professional and artistic values of architecture collide with the autonomy of inhabitants and the tasks of owners to modernize housing. Although these values do play a role we believe the paradox is more complex than a clash of values of different stakeholders, for instance because architects have invested and are investing much work in finding constructive ways out of the paradox. In this paper we review and develop these efforts.

In our work (Eloy, Vermaas and Andrade, 2017; Eloy, Dias and Vermaas, 2018; Eloy *et al.*, 2021; Vermaas and Eloy, 2021) we aim at an approach that enables inhabitants to adapt their housing within the architectural language of the original design. We call it the *Inhabitant-Driven Customization* approach to housing customization and present the tool *MyChanges* as a first implementation. MyChanges is a shape grammar-based tool developed to enable inhabitants to customize their houses in the Siza Vieira Malagueira housing complex in Évora, Portugal. With this specific implementation the focus in this paper is on housing with high architectural value for which customization is typically controversial and broadly discussed in architecture and even the press. Yet the customization paradox occurs for all housing originally designed by architects even if individual cases do not enter the public debate. We advance the Inhabitant-Driven Customization approach and the MyChanges tool as a general way out of the customization paradox for housing.

The initial presentation of the MyChanges tool to professional stakeholders led to cautious and divergent responses, suggesting that the Inhabitant-Driven Customization

[1] In this paper we use the expression "architectural integrity" to express the quality of the buildings that as a whole follow architectural design principles. We use this expression following the Krakow Charter (Bureau Krakow, 2000) and the Revision of the Operational Guidelines on the Implementation of the World Heritage Convention (UNESCO, 1999).

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approach will also be confronted with the customization paradox. In order to analyze this possible predicament, we have embedded the presentation of MyChanges within a survey of housing customization approaches in architecture. We start by describing the main existing approaches to housing customization in Section 2 and presenting the Inhabitant-Driven Customization approach. Section 3 introduces MyChanges as a first concrete implementation of this approach, and gives its evaluation by the professional stakeholders. In Section 4 we begin the general evaluation of the Inhabitant-Driven Customization approach by formulating nine conditions for the main approaches to housing customization. A qualitative comparative assessment of these main approaches is presented in Section 5. Finally, it is argued that the Inhabitant-Driven Customization approach avoids the customization paradox by creating a co-design process in which inhabitants and architects alternately customize housing.

2 Architectural approaches to housing customization

For this paper we use customization as the actions taken by or for inhabitants when they transform their houses after the housing in question has been designed and built and the inhabitants have lived in it for some time. Customization occurs when inhabitants adapt their house to their own needs and preferences. Inhabitants can to some extent perform the customization themselves, but when more substantial changes are required, terms of ownership and building regulations may require architects to intervene. In this case, various approaches are available. Some approaches attribute a central role to architects, when the original architect of the housing creates a 'catalogue' of possible future adjustments upfront, for example, or when (other) architects later create such catalogues. Other approaches, such as the participatory design tradition in architecture, make the inhabitants more central to the proceedings. Participatory design emerged in the 1960s with several architects devising strategies to include inhabitants in housing design. Participatory design practices are "noticeably different from normative architectural design" (Luck, 2018, p. 7). Henry Sanoff (2000), a pioneer in participatory design, argued that when residents participate actively in the development processes, there is a greater sense of public spirit and user satisfaction. In order to understand all these approaches to housing customization, we will proceed with a review.

Existing approaches to housing customization

The need to adapt houses to the preferences of their inhabitants is a topic architects are

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concerned with for long. Several ideas had emerged during the 20th Century to deal with this topic, as, for instance, the plans by Le Corbusier for Algiers (1933) in which a group of very different housing units were designed in the infill of the curvilinear wall of the majestic, elevated highway crossing the city of Algiers.

The first approach to housing customization that will be considered in this paper is the Open Form concept developed in the late 1950s by Oskar Hansen and presented at the CIAM congress in Otterlo (1960). Hansen positioned the inhabitants at the center of the decision-making and made them the ones who could choose whether to invite an architect or other professional to participate in the design of the house. Open Form leaves to inhabitants "a margin for evoking one's own latent essence" (Hansen, 1960). For Hansen, the architect's role should be an auxiliary one and by empowering the inhabitants he emphasized the creative role of the individual as the co-author of the space (Monoskop, 2020).

Friedensreich Hundertwasser (1958) offers a radical extreme of Open Form in his Manifesto Against Rationalism in Architecture. In this manifesto he argued that the apartment-house tenant "must [..] be allowed to cut up the walls and make all kinds of changes, even if this disturbs the architectural harmony of a so-called masterwork, and he must be able to fill his room with mud or children's modelling clay".

In 1964 Fumihiko Maki published his theory on Collective Form (1964), which explores how to empower in design the different people that live in and create public environments. Within Collective Form Maki includes Group Form, a bottom-up planning approach from which individual actions emerge and, in a process of negotiation between people, a spatial composition such as a house or a city is generated.

The Open Building approach by Habraken (1972) advocates that a support system with basic infrastructure should be designed by architects, whereas the design of individual apartments, including possible later changes, should be left to the inhabitants. In order to develop the Open Building approach further, participatory design was chosen so that inhabitants could design their houses, while architects are "not to be made entirely redundant but must learn to adopt a new, less arrogant role" (Habraken, 1986). Current interpretation of this approach led to the concept of Superlofts by Marc Koehler Architects, and SketchBlock by ANA architects. These approaches use the flexible and open framework of Open Building and offer inhabitants the freedom to design and/or self-build their apartments. More

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contemporary examples that fit in the Do-It-Yourself strategy are the Solids in Amsterdam (Kendall, 2013) and the Grundbau and Siedler proposal of BeL Sozietät für Architektur.[2]

The Incremental Design housing approach is mainly used in developing countries and for addressing housing shortage in the low-cost housing sector. This approach, promoted by Reinhard Goethert (2010), is a step-by-step integral urban development process which addresses the needs of communities and citizens. According to Greene and Rojas (2008) the incremental process encompasses three phases: access to land, construction of a basic housing nucleus, and incremental improvement of the houses. One of the strategies promoted is the "core house" concept by which families are provided with a fully serviced plot of land and a core of a house (e.g., a kitchen/bathroom unit). Inhabitants can then add an extension based on their needs and resources. In other cases, the core of the house contains also in advance one extra room for shelter and for the rest of the family's needs during the first period of living in the house (Breimer and Napier, 2013). In an incremental design architects can upfront give solutions for future expansion phases to the future inhabitants. This approach is being extensively used by the Elemental office (Aravena and Iacobelli, 2016), which designs a 'catalogue' of customization solutions for future phases.

In the 1960s the Self-Help (and self-built) houses approach for the developing world was largely advocated by John Turner (1976). Turner states that the "matching of housing services with their users' priority needs is clearly critical." The concept of self-help housing does not necessarily include the architect in the process, although architects may be part of it, thus making it assisted self-help housing. Self-help houses are built on the initiative of inhabitants, with their own means and usually their own work force.

The above approaches to housing customization concern both the initial design and future alterations of existing buildings. In architecture, the Venice Charter (ICOMOS, 1965) and the Nara Document on Authenticity (ICOMOS, 1994) provide the theory and principles for customizing buildings. The Venice Charter establishes principles that restrict changes to the "layout or decorations of the buildings" and movements of "all or part of a monument" and, above all, stipulates that restoration work "must stop at the point where conjecture begins, and (…) any extra work which is indispensable must be distinct from the architectural composition and must bear a contemporary stamp." Later, the Nara Document states that

[2] More information at https://www.internationale-bauausstellung-hamburg.de/en/projects/the-building-exhibition-within-the-building-exhibition/smart-price-houses/basic-building-and-do-it-yourself-builders/projekt/basic-building-and-do-it-yourself-builders.html

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values attributed to cultural properties may differ from culture to culture and that "heritage properties must be considered and judged within the cultural context to which they belong". The Krakow Charter (Bureau Krakow, 2000) emphasizes that the purpose of conserving buildings "is to maintain their authenticity and integrity, including internal spaces, furnishings and decoration according to their original appearance." The Nara Document proposes moreover that the restoration of sites should anticipate the change and transformation of sites in a sustainable way with regard to heritage, social and economic aspects. Although these documents refer specifically to monuments, sites and heritage values, we see an analogy with the customization of ordinary and modern architecture independently of whether the housing is classified as heritage; in this paper we take the Venice Charter, Krakow Charter and Nara Document as delineating a separate approach to customization.[3]

Some problematic cases of customization

Although customization approaches have gained a foothold in architecture, they do not provide clear solutions to the paradox of customization. There are several examples of small- and large-scale alterations made by inhabitants to both collective and individual housing that can be taken as instances of the customization approaches, yet had problematic outcomes.

One of the most paradigmatic cases of customization is the Quartier Modern Frugès by Le Corbusier. This housing complex by Le Corbusier, currently classified as an Historic Monument, was received badly by inhabitants and local architects, and during decades inhabitants made many changes to their houses thus mischaracterizing the original architecture (Boudon, 1972). Two other cases of customization involving collective housing buildings occurred in Casablanca in apartment buildings dating from the 1950s. In both the Nid D'Abeille (by Georges Candilis and Shadrach Woods) and the Sidi Othman apartment buildings (by André M. Studer), the inhabitants have appropriated the buildings and drastically changed the façades and volumetry. Closed elevated patios and the addition of new windows have had a huge impact on the architectonic character of the building and its relation to the outside

[3] Jokilehto (2006) refers to modern heritage as architecture that has been recognized for its value by criteria required to be considered "outstanding universal value" following the World Heritage Convention, namely the Operational Guidelines on the Implementation of the World Heritage Convention (UNESCO, 1999). Examples are the Bauhaus buildings, the Rietveld-Schröder House and the Quartier Modern Frugès by Le Corbusier built in 1924-25 for regular labor housing (also discussed in the main text).

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(Culley, 2011). Hence, customization approaches such as Open From, Collective Form and Manifesto Against Rationalism that adopt more free forms of user-driven customization can damage architectural integrity.

The Malagueira housing complex by Siza Vieira is a prime example of a participatory process and the Incremental Design approach to customization. Yet this housing complex was heavily criticized by its inhabitants and in the press because of its monotonous and inhuman appearance (Mota, 2015). Customization approaches can also block modernization. Over time, some inhabitants of Malagueira have made changes to their houses, some respecting the rules defined by the architect and others not. A similar conclusion holds for Quinta Monroy by Elemental (Aravena and Iacobelli, 2016), where the Incremental Design customization approach was also followed. Elemental organizes workshops for inhabitants to present the criteria for changes and explain how individual decisions can influence the value of the complex. Elemental's plan for the evolution of the houses was to a large extent followed, although some inhabitants broke the rules (Fernandes, 2015).

New approaches to housing customization

The search for customization approaches still continues, leading to new proposals, including the new resources which computing offers to architecture. Mass customization, as initially defined by Stanley Davis in his book *Future Perfect* (1987), and later by Joseph Pine (1992), is an approach for developing, producing and delivering affordable goods and services with enough variety and customization that nearly everyone finds exactly what they want. Rebecca Duray (2002) adds that customization is the provision of "personalized products at reasonable prices". This concept was later applied to houses, using standard housing components combined according to the individual user's choice, thus creating customized houses (Noguchia and Hernandez-Velasco, 2005). A recent new approach to mass customization explores the possibilities afforded by digital technologies and algorithmic design to produce economic and highly differentiated solutions on a mass scale (Kolarevic and Duarte, 2019).

This paper introduces the new Inhabitant-Driven Customization approach based on mass customization and presents MyChanges as an implementation. The defining characteristic of the Inhabitant-Driven Customization approach is that inhabitants are given tools for adjusting their housing. These tools incorporate the design rules for the housing as defined by architects and can be upgraded during the life of the building, with or without the participation of the inhabitants. MyChanges is by the authors and collaborators developed for

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housing in the Siza Vieira Malagueira complex and is a first instantiation of the Inhabitant-Driven Customization approach. MyChanges generates customizations for housing in this complex using a shape grammar system(Eloy *et al.*, 2021), as described in the next section. This approach and tool are, as said, meant to be generally applicable to housing buildings originally designed by architects.

3 Inhabitant-driven housing customization

The Inhabitant-Driven Customization approach that we propose consists of any system that:

(1) gives inhabitants the means to design housing customization solutions and
(2) is created by architects to generate solutions that satisfy the architectural rules of the housing.

An Inhabitant-Driven Customization system is therefore, in terms of characteristic (1), a stand-alone design tool for inhabitants, yet, under characteristic (2), also a design tool that is authored by architects.

A bottom-up participatory implementation of the Inhabitant-Driven Customization approach is one in which architects create the design tool based on input by inhabitants in such a way that the customizations desired by inhabitants are also eventually made possible by the design tool. This input can come in the form of the actual physical customizations that inhabitants have adopted, or as design ideas created in collaboration with architects. The Malagueira MyChanges tool is a case in point, as is the Rabo-de-Bacalhau transformation grammar (Eloy and Duarte, 2015).

A top-down implementation of the Inhabitant-Driven Customization approach is possible as well, as when architects create the design tool on the basis of only their expertise. When architects make top-down only a few customization solutions available, the Inhabitant-Driven Customization approach resembles Incremental Design. When architects allow a large set of possible changes, the Inhabitant-Driven Customization approach resembles the Open Building and Mass Customizations approaches.

MyChanges

For giving a first implementation of the Inhabitant-Driven Customization approach we briefly describe MyChanges, which is a shape grammar-based tool that includes design rules

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for the generation of design solutions for housing customization (Eloy, Dias and Vermaas, 2018). We use this first implementation in this paper as a means to collect feedback from professional stakeholders in architecture on the Inhabitant-Driven Customization approach.

The core of MyChanges is a transformation grammar developed to establish a balance between the visible transformations that Malagueira inhabitants had made to their houses and the original architecture of Siza Vieira (Figure 1). The tool incorporates design rules for housing customization solutions. These rules were defined during a workshop held with architecture students in which they were confronted with the original design of Siza Vieira for Malagueira and the alterations that inhabitants have done to the façades of their houses (Eloy, Dias and Vermaas, 2018). By using a computer with MyChanges, the user/inhabitant can see his/her house façade and the customizable elements of the façade (windows, doors, gate, wall, ornaments, and railings). MyChanges comprehends a shape generation feature with which the user can act on those elements and, e.g., add window and door frames, change their colors, add different ornaments, and add railings for extra housing protection. By manipulating these transformation possibilities, the user is aware of his/her intentions and the impact they will have on the house and the neighborhood.

The Malagueira transformation grammar follows the Inhabitant-Driven Customization approach, since: 1) it aims to give inhabitants the means to design housing customization solutions and 2) is created by architects to generate solutions that satisfy the architectural rules for the Malagueira housing complex.

The MyChanges tool currently includes rules for the generation of alternative designs for the façade of the Malagueira houses (Figure 2). In the future it can include rules for more alterations, such as changes to the layout of the interior.

Figure 1. Malagueira: current situation of housing customization (the houses in the photo on the left were not altered on the outside, the houses in the middle and on the right were)

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Figure 2. MyChanges mock-up, (left) window frame option selected, (middle) color menu and color selected, (right) adornment menu.

Evaluation of MyChanges

In (Eloy *et al.*, 2021) we presented MyChanges and its testing with inhabitants of the Malagueira housing complex. The results of the surveys with the inhabitants showed that a tool like MyChanges would find acceptance among the inhabitants. It should also be added that when the research team went to Malagueira to carry out the tests, they could sense that several inhabitants were uncomfortable with the presence of the researchers. Surveys were done individually and in a face-to-face conversation. When the researchers announced that they were from an Architecture school, several inhabitants immediately declined to participate in the survey and others announced that they had not altered anything in their houses, even before we started to show our work. Tensions between the inhabitants, the architectural community and the institutional powers were quite noticeable.

In the current paper we present the results of the evaluation of MyChanges by architects and other professional stakeholders. Five professionals involved in various ways with the Malagueira housing complex were interviewed in February 2020 during a face-to-face meeting with the researchers. Two of these professionals were architects, one a sociologist, one an art historian, and the last a director of a housing cooperative in Malagueira. The goal of these interviews was to gather the opinions of these stakeholders regarding housing customization in Malagueira and their assessment of the MyChanges tool. Interviewees were chosen with the following criteria: i) architecture professionals should have been involved in refurbishing or studying Malagueira houses; ii) humanities professionals should have been involved in studying the Malagueira complex; iii) social science professionals should have been involved in fieldwork on social housing, with preference to Évora and Malagueira reality; iv) other professional stakeholders should be directly involved in the Malagueira housing cooperatives. Academic and Architecture work was searched to select people for criteria i),

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and ii). For selecting interviewees that comply to iii) and iv) several cooperatives and public housing institutions of the municipality of Évora were contacted.

The interviews consisted of three parts. First, the researchers asked open questions about the Inhabitant-Driven Customization approach, and then presented the MyChanges design tool using a mock-up and explaining its use. Finally, the professionals were asked about their assessment of the MyChanges tool.

Malagueira customization interview results

Opinions on the customization effort and the Inhabitant-Driven Customization approach underlying the MyChanges tool revealed differences between disciplines. The architects and the art historian recognized the need for customization and emphasized the value of architecture and the sovereignty of the architect; the sociologist and the director of the housing cooperative addressed the issue more from the perspective of the inhabitants and their needs. The responses were given with some caution, in line with the tension felt when the first tests involving the inhabitants were carried out.

When asked about their view on the customization of houses by inhabitants in Malagueira, the interviewees argued that customization should be allowed, since it creates "empathy with the project", enabling "inhabitants to appropriate their houses". The architects and art historian stated that such customizations should "respect the project" and establish "a balance between maintaining the singularity and value of the architecture and allowing inhabitants to adapt their houses". The sociologist pointed out that customizations by inhabitants often "do not comply with what the architect wants and allows the inhabitant to do."

When asked if the inhabitants of Malagueira should be allowed to customize their houses, all the answers followed the same reasoning. One architect said that inhabitants should be allowed to customize their houses "up to a certain level (…) with respect for the surroundings and the original project". The art historian stated that inhabitants should be allowed and helped to define the values of "singularity, space, space definition, urban implantation and scale" so that the changes do not "affect the fundamental aspects (…) and preserve the architecture essence". The sociologist and the director of the housing cooperative were also in favor of customization although "just enough, as long as the structure and the façade are not customized" and still "complying with the rules".

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As a follow-up to the question on whether inhabitants should be allowed to customize their houses, the participants were then asked whether there should be limits to customization. The architects stressed that “obviously” limits should exist. Limits were defined as “when what inhabitants do is no longer called personalization and becomes transformation. When they start to change the typological and architectural characteristics”, since “the object has a coherence”; and inhabitants should “think in a more integrative and less individual way”. Nevertheless, it was considered possible to “make adaptations that have to do with purely aesthetic issues, to apply tiles, change materials, etc.”. For the art historian, the limits “are on the level of the built implantation and regarding the façade configuration, which is not reversible.” For the sociologist, limits should exist and they “are the structure and the façade”, and for the director of the housing cooperative these limits “are the ones included in the rules of the [incremental] plan”.

When asked if customization by inhabitants conflicts with preserving the original architecture of Malagueira, the answers differed. One architect said that they do conflict and that “in some situations, the customization is highly dissonant”. The other architect maintained that due to the size of the project “this customization does not seem (…) to jeopardize the architectural project at all”. For the art historian, the current customizations do not “compromise the heritage value and the uniqueness, importance and quality of the architecture”. The sociologist’s view was that in some cases “from a visual perspective” some customizations are “a bit excessive”. Finally, the director of the housing cooperative took the view that there was no conflict.

The MyChanges tool interview results

Regarding MyChanges itself, four questions were put to all the professionals and the answers were ranked on a scale from 1 to 5, from minimum to maximum, respectively.

Question A was related to how pleased the interviewees were with the idea that inhabitants could obtain a tool like MyChanges to customize their houses. Four were very pleased (ranking 5) and one architect was less pleased (ranking 4).

Question B concerned the usefulness of this tool for inhabitants to customize the outside decoration of their houses. Four professionals totally agreed (ranking 5) with its usefulness and one architect agreed less (ranking 4), believing that inhabitants customize the façade on impulse.

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When asked through Question C whether a tool like MyChanges could help to solve the conflict between inhabitants (and their wish to customize) and architects (and their wish to maintain the architectonic language), four fully agreed (ranking 5), and one architect was reserved (ranking 3).

For Question D, whether a tool like MyChanges could help the customization by inhabitants without disrespecting the rules defined by the architects, all five professionals were very pleased (ranking 5) with the MyChanges design tool and with the opportunities it offered the inhabitants.

Reflection

The paradox of customization is visible in this assessment of MyChanges by the professional stakeholders. Although the architects stated that customization should take place, they also said that it should "respect the project" and may occur "up to a certain level." Such a statement is evidence that the professional stakeholders consider the inhabitants' opinions on their own houses and their knowledge of how to act on non-structural issues, as insufficient. From the interviews it can therefore be concluded that inhabitants should not act alone. Moreover, the sociologist pointed out that the alterations which the inhabitants want are not in line with what the architects want and that this leads to illegal alterations. There seems to be no place for discussion, and it appears to have reached a dead-end – both architects and non-architects defend customization, yet immediately add many limitations to it. Due to this paradox the issue of housing customization is more than 40 years after construction still not resolved for Malagueira.

The assessment of the MyChanges tool seems furthermore to suggest that the Inhabitant-Driven Customization approach is also not escaping the paradox of customization. For exploring this possibility and eventually rejecting it, we review the Inhabitant-Driven Customization approach more generally against conditions that in architecture are held for housing customization.

A further issue that emerges from the use of a tool such as MyChanges is the one about authorship, specifically about the relation between the authorship of the architect and the one of the inhabitant, and the relation between the authorship of an architect who customizes a building and the authorship of the architect who originally design the building. The transformation grammar for the MyChanges tool is devised from: i) the original incremental solutions that Siza Vieira, the original architect of the Malagueira project designed

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for future alterations of the houses; and ii) alterations by inhabitants that we observed as a pattern. Authorship of the MyChanges tool is therefore shared with Siza Vieira, the developers of the transformation grammar, and the inhabitants that made the incorporated patterns. This distribution of authorship becomes somewhat simplified if the original architect of housing would him- or herself design the transformation grammar for generating customization options, and would later update the grammar when inhabitants call for or actually perform alternations that were initially not envisaged. Yet, as soon as the architect of the original design is not available for updating the original grammar (e.g., by death, or by a wish to not further work on the design), then other architects should take over this task to solve newly identified needs for customization.

It is our position that in architecture there is already an accepted professional practice of architects customize housing of other architects. The MyChanges tool, or the Inhabitant-Driven Customization approach in general, can adopt that practice, including visions on the way authorship is then related or shared (Picon, 2016) .

MyChanges and the Inhabitant-Driven Customization approach generally, also do not introduce new elements in the authorship relation between architects and inhabitants, but draw from discussions about authorship that takes places in, for instance, participatory design especially when digital design is used. For such cases Mario Carpo (2013) has written about the digital indeterminism that has caused the dissolution of architectural authorship. The use of parametricism, as the one used in a transformation grammar as MyChanges, removes the limits for the possible variations of the design solutions and then opens the way to an infinite number of solutions whose author, defined in a “humanistic and modern” approach, is not identified (Carpo, 2013). In MyChanges, using the words of Carpo “every user can be a maker”, and authorship is shared between the architect that defined the concept, the person that defined the parametric tool and the user that defines a specific design using the MyChanges tool (Carpo, 2013, p. 48).

4 Conditions for housing customization approaches

The divergent responses to MyChanges as described in the previous section, seem to indicate that the stakeholders have diverging views about what conditions housing customization approaches should meet. For investigating this possibility and further analyzing the paradox of customization, we continue with exploring what general conditions on housing

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customization are advanced in architecture. With this exploration we can make plausible that the Inhabitant-Driven Customization approach avoids the customization paradox.

The discussion in Section 2 did not amount to a unique vision of what such conditions on housing customization should be, but enabled us to abstract from each approach the fundamental goals and relevance to architecture. In some fields of architecture, such as monuments and cultural sites, there are more articulated standards and charters for customization, yet such resources are not always available or made explicit for housing and other more ordinary buildings. Our exploration of conditions is therefore to a large extent a first elucidation of views in architecture on the customization of housing; we give this elucidation on the basis of further analysis of the architectural approaches to customization as discussed in Section 2.

We discern four types of conditions on approaches of housing customization and describe nine conditions within these types. The paradox of customization already gives two types: conditions on customization approaches for realizing modernization of housing and conditions for preserving the architecture. A third type concerns conditions for inclusivity. The fourth contains conditions for upgrading customization possibilities. Finally, given the ambiguity observed in the responses to MyChanges, it cannot be assumed from the outset that there is consensus in architecture on the acceptability of the conditions that we list, or that they are consistent in the sense that all the conditions can be met simultaneously.

Conditions for modernization and personalization

A first condition, C1, on approaches to housing customization is that they should *allow for modernization*. Modernizations are adjustments to housing to meet new habitability standards in terms of functions and technology and may affect the layout of the housing. Modernization can include refurbishment, e.g., the upgrading of thermal insulation, and conversion, when new elements such as cable television are added (Giebeler *et al.*, 2009).

Functional modernization can include adapting housing to new household needs and desires, e.g., the addition of new areas such as new bathroom facilities and new rooms, or the conversion of existing areas into others with different functions. Technical modernization can include everyday construction work and construction work on infrastructures (services). Examples of the former are installing double glazing or a new wooden parquet floor, infrastructure modernization may include upgrading telecommunication installations or adding air conditioning.

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A second condition, C2, is that customization approaches should *allow for personalization* of housing. Personalization consists of changes to the "houses' interior layout, finishes and decoration that involves movable items" and may include "structural modification of the houses" (Jusan and Sulaiman, 2005, p. 503). According to those authors, personalization happens when there is a "person-environment incongruence", and allows for "generating environmental meaning that leads towards achieving one's values and goals".

Conditions for preserving architecture

The preservation of existing architecture during customization is explicitly addressed in architectural theory, but principles and practical guidelines are scarce. The official standards on the conservation of heritage give some guidance. The Venice Charter, for instance, "prohibits additions that detract from the interesting parts of the building, its traditional setting, the balance of its composition and its relation with its surroundings" (ICOMOS, 1965).

Damla Misirlisoy maintains that the "character and identity" of buildings should not be destroyed, "appropriate materials" must be used, and "new additions have to be separated from the old ones that can be removed any time without destroying the original building". Finally, "a new addition should complement and contribute to the sense of proportion, disposition and historical pattern" (Mısırlısoy, 2017).

There are few guidelines for intervening in contemporary architecture. Elemental (Aravena and Iacobelli, 2016, p. 468) takes the position that it is the structure of houses and the repetition of this structure in their Quinta Monroy housing buildings that protect the architecture and quality of the neighborhood. Elemental considers that at least "fifty percent of the urban front needs to be defined with the initial dwelling" in order to avoid "deterioration of the urban environment by spontaneous buildings of uncertain quality" (Aravena and Iacobelli, 2016, p. 492).

We derive two conditions for preserving architecture from these principles and guidelines. The first (C3) is that housing customization approaches should *preserve the structure* of housing. The second (C4) is that they should *preserve the architectural language* of the housing.

Preserving structure means that a building has the same structure before and after customization. This structure can be: the whole building (following a more orthodox conservation style), the entire support (as in the Open Building approach, for example), or some other part of the structure. Even Façadism may count as an instance of structure-

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preserving, since it requires from customization that the façades of buildings are kept.[4] There are some variations within this approach. It can, for instance, include the requirement that additions are clearly discernible from the original structure or that additions are removable from the structure, as the heritage conservation charters stipulate.

In language-preserving customization the building shares the same architectonic language before and after customization. The architectonic language can be considered: i) the language defined by the original architect (e.g., Siza Vieira, for Malagueira); ii) the language that architectural researchers determine (e.g., Flemming (1987), for Queen Anne houses); iii) the language which the inhabitants define (when, for example, inhabitants buy a new door from a DIY store that matches the style of the house). There are also some variations in this approach. A language includes elements and rules[5] and one variation is that certain elements can be added or removed from the language preservation condition (when, for instance, air conditioning can be added in a technical modernization). The second variation is that rules can be added and removed (when, for instance, due to a new lifestyle, the rule is removed that there should always be a door between a kitchen and any other social area).

Conditions for inclusivity

In this paper we take inclusivity as meaning that all stakeholders, specifically inhabitants and architects, can concur in the way the built environment is designed.

Yona Friedman (1971) argues that since architects are working for "millions of individuals" and cannot study the behavior of each user, they instead construct an ideal perfect user that does not capture the individual "imperfect" users. Since architects cannot ascertain all user preferences, they should devise methods of "promoting choice among users themselves". Hence, participatory design and co-design approaches are needed which, in terms of customization, means that approaches should *allow inhabitants to change their housing*. This is our fifth condition, C5.

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[4] Characterizing Façadism as structure preserving is arguable somewhat counter-intuitive because Façadism may allow demolishing the full supporting structure of buildings.

[5] Elements are construction elements (walls, doors/windows, skirting boards, decorations, etc.) and spaces (bathroom, bedroom, living room, etc.). Examples of rules, as described in for instance shape grammar applications for architecture (Eloy and Duarte, 2015), include connections between spaces, forms of spaces, existence (or not) of spaces, and positions of elements.

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A participatory process assumes that “a collective decision has been reached through a deliberative, democratic process.” (Luck, 2018) These processes are educational “not only in terms of giving and receiving but also of sharing knowledge”: professionals involve citizens/users in the decision-making process, finding acceptance for them.

Co-design is a stronger variant of participatory design, in which professionals and citizens/users collaborate closely in a creative process, interacting and sharing in order to find a design (Noennig, 2019). Co-design *allows inhabitants to design the changes* and that is our sixth condition, C6.

All housing customization approaches place an emphasis on including inhabitants, although architectural expertise is still required, leading to condition C7: a customization approach *allows architects to design the changes*.

Conditions of upgrading

As mentioned in the description of the Incremental Design and Mass Customization approaches, architects can anticipate customization by including a catalogue of alterations to the housing in their designs. This catalogue may be a simple document with a small set of permitted or advised changes, as Siza Vieira provided for Malagueira, or a design system that uses rules to offer a large number of possible changes. Examples of these latter more open approaches are generative systems such as the ones by Eloy and Duarte (2015) and Eloy et al. (2018) for existing buildings. An open catalogue gives inhabitants more freedom, supporting a further condition, C8, that housing customization approaches should *include generation of changes*.

Frediani (2015) discusses a paradox in participatory design related to time. Since the common goal of participatory design is to achieve the “elaboration of an agreed on and finite project”, incremental solutions to possible future alterations of buildings are predefined and have therefore a limited time horizon. Upgrades needed after one or more decades are typically not included in the original design.

According to Jusan and Sulaiman (2005), when developers determine changes upfront by means of a catalogue, this presupposes that they first produce the catalogue and then the users select the options given to them by the developers to personalize their houses. Since this process is led by the developers, Jusan and Sulaiman hold that it might be difficult to arrive with such catalogues at long-term personalization programs.

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Upfront designed catalogues or software systems that generate such catalogues have the disadvantage of being frozen in time and not necessarily open to the changing needs and desires of users, or to new lifestyles and technologies. The alternative is to make customization systems upgradable over time. This leads us to the last condition, C9, namely that *customization options are upgradable*, resulting in a more dynamic catalogue to which new design alternatives can be added over time.

5 Evaluating the customization approaches

In the previous section nine conditions were derived for housing customization approaches and we can now take stock by returning to the different approaches presented in Section 2. Table 1 presents a qualitative evaluation of these approaches by analysis of the extent that they meet the nine conditions.

Table 1 – The housing customization approaches and how they meet the nine conditions on customization (+ yes, - no, ± in some cases and with rules)

Conditions for housing customization	Open Form and Collective Form	Open Building	Incremental Design	Self-help Housing	Manifesto Against Rationalism	Venice-Nara-Krakow	Inhabitant-Driven Customization
C1: Supports modernization	+	+	±	+	+	±	+
C2: Supports personalization	+	+	±	+	+	±	+
C3: Preserves structure	-	+	+	±	-	+	±
C4: Preserves architectural language	-	-	+	±	-	+	+
C5: Inhabitants determine the changes	+	+	±	+	+	-	+
C6: Inhabitants design the changes	+	±	-	+	+	-	±
C7: Architects design the changes	-	-	+	-	-	+	+
C8: Includes generation of changes	-	-	+	±	-	-	+
C9: Customization options are upgradable	-	-	-	-	-	-	+

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In reviewing this evaluation, it can be observed that none of the customization approaches fulfil all nine conditions. While the conditions *supporting modernization* (C1), and *personalization* (C2) are more or less fulfilled by all the approaches, others, such as *architects design the changes* (C7), *including generation of changes* (C8) and, in particular, *customization options are upgradable* (C9) are barely fulfilled.

One basic condition for customization is that it should enable *inhabitants to determine the changes* (C5) and all the approaches specifically intended for housing acknowledge this (the Venice-Nara-Krakow approach focuses more on heritage). The further condition of enabling *inhabitants to design the changes* (C6) is not satisfied so well by some of the approaches. In the case of the Inhabitant-Driven Customization approach, although users can determine the changes, they cannot fully *design the changes* (C6) since the changes the users can choose from are constrained by a grammar that architects have defined (based on various aspects, including alterations desired by inhabitants).

The involvement of *architects in designing the changes* (C7) is included from the outset in some approaches, such as Incremental, Venice-Nara-Krakow and Inhabitant-Driven Customization, but not mandatory in most other approaches. And only three approaches (Incremental, Self-help Housing, and Inhabitant-Driven Customization) meet the condition of *generation of changes* (C8).

The possibility that *customization options are upgradable* (C9) is only included in the Inhabitant-Driven Customization approach. In fact, a tool like MyChanges allows for the generation of a large set of design alternatives (C8) and for the inclusion of new customization options in upgrades of the transformation grammar of MyChanges (C9).

6 **Discussion and Conclusion**

This paper began by pointing out that housing customization is a paradox in architecture, since modernizing buildings can also damage their architectural integrity. It proposed the Inhabitant-Driven Customization approach for housing and described a first implementation: the MyChanges tool for customizing housing in the Malagueira complex. In this final section we argue that this new approach avoids the customization paradox.

We gave in section 2 a survey of the main customization approaches for housing. These approaches have gained a foothold in architecture, yet do not provide clear solutions to the paradox of customization: there are several examples of small- and large-scale alterations

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to housing made by inhabitants that are in line with the main customization approaches but have resulted in architectonically damaging outcomes.

We presented in section 4 nine conditions advanced in architecture for assessing customization approaches for housing and arrived at a qualitative evaluation of how the different housing customization approaches respond to these conditions.

The evaluation demonstrates that some of the nine conditions for customization are easily accomplished by the approaches (such as C1: *supports modernization* and C2: *supports personalization*), while others are not accommodated in most of the approaches (such as C8: *includes generation of changes* and C9: *customization options are upgradable*).

Using these conditions, it can be argued that the paradox of customization in architecture exists because the modernization (condition C1) of buildings can damage their architectural integrity (violating both C3 and C4) if it is carried out by non-architects (satisfying C5 and C6 but violating C7). In fact, our assessment shows, that the autonomy of inhabitants, both in determining and designing the changes (conditions C5 and C6), is present in most customization approaches, whereas the sovereignty of architects within the decision-making process (C7) and the preservation of the architectural structure and language (C3 and C4) feature less. Among the approaches in which inhabitants have greater autonomy, architects and architecture are less relevant to the process (e.g., Open Form, Open Building, Self-help), whereas when inhabitants have a lesser or inexistent role, architecture is sovereign (Incremental design and Venice Charter).

The Inhabitant-Driven Customization approach that we propose can escape the paradox of customization because it enables both architects and inhabitants to play a central role in the customization. For giving this argument, we again focus on the MyChanges tool. This tool defines an in-time extended co-design process in which inhabitants and architects shape customization in an iterative manner and meets in this way to a large extent all nine conditions on customization. With the MyChanges tool architects create (condition C7) a wide range of customization options (condition C8) for inhabitants that preserve the structure and the architectural language of the housing (conditions C3 and C4), and that enable inhabitants to modernize and personalize their housing (conditions C1 and C2) by determining the customization the inhabitants like (condition C5). In addition, inhabitants can supply with the MyChanges tool architects with new opportunities for customization, thus partly meeting condition C6 that inhabitants co-design the future space of customization options, and creating an ongoing possibility for upgrading this space (condition C9).

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We developed the MyChanges tool for the customization of a housing complex with distinct architectural value: the Malagueira housing complex in Évora designed by Álvaro Siza Vieira. The validity of our argument that the Inhabitant-Driven Customization approach may escape the customization paradox may therefore be limited to such housing complex, and not accepted for housing with extraordinary architectonic iconic value. For say Le Corbusier's Unité d'Habitation, the condition of preserving structure (C3) may trump competing conditions for modernization and personalization. Yet, we submit the Inhabitant-Driven Customization approach as a way to resolve the customization paradox for housing in general.

7 Acknowledgments

The authors would like to thank Fábio Costa and Micaela Raposo who carried out the interviews as well as the reviewers for their constructive comments that helped improving this paper. This project was partially funded by EEA Grants FBR_OC1_020 – ISCTE and by FCT under grant UIDB/04466/2020.

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