Housing transformations and their impacts on the well-being of dwellers

Transformações habitacionais e seus impactos no bem-estar dos residentes

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Abstract

Housing transformations have been studied over time. Numerous Post-Occupancy-Evaluation (POE) studies reveal user-initiated alterations occurring in Brazilian Social Housing (SH). These transformations have specific objectives, such as additional space, refurbishment, and improvement, or upgrading. However, results of transformations are not always positive, and may affect dwellers' well-being through losses in environmental comfort. A critical investigation using the Systematic Literature Review (SLR) method analysed forty-seven studies to understand what needs and requirements stimulate SH projects' upgrading and how transformations impact well-being. In addition, an in-depth analysis was made to assess aspects of environmental comfort, safety, design, layout and economic aspects that affect people's well-being, and improve their quality of life. Results contribute to supporting upgrading processes of existing SH and to guide the improved design of new SH projects based on the desires and well-being requirements of low-income families.

Keywords: Transformation. Social Housing. Dwellers' well-being.

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Recebido em 11/12/21
Aceito em 24/02/22

Resumo

As transformações de habitações têm sido estudadas ao longo dos anos. Muitos estudos sobre Avaliações Pós-Ocupação (APOs) evidenciam a ocorrência de alterações iniciadas pelos usuários em Habitações de Interesse Social (HIS) no Brasil. Estas transformações têm objetivos específicos, tais como: adição de espaço, remodelação e melhoria, ou upgrading. Entretanto, as condições resultantes dessas transformações nem sempre são positivas, e podem afetar o bem-estar dos usuários por meio de perdas no conforto ambiental. Um estudo crítico desenvolvido a partir de uma Revisão Sistemática de Literatura (RSL) analisou quarenta e sete pesquisas para entender quais necessidades e requisitos estimulam melhorias em HIS, e como as transformações impactam o bem-estar. Além disso, a análise foi aprofundada para se avaliar aspectos de conforto ambiental, segurança, projeto, layout e aspectos econômicos que afetam o bem-estar das pessoas, e melhoram sua qualidade de vida. Os resultados contribuem para apoiar os processos de upgrading de HIS existentes, e pode orientar o aprimoramento o design de novos projetos de HIS com base nas necessidades de bem-estar e requisitos das famílias de baixa renda.

***Palavras-chave**: Transformação. Habitação de Interesse Social. Bem-estar de usuários.*

Introduction

The transformation of houses is an age-old human activity, and the literature on the topic is extensive. Over the last fifty years, research has shown an interest in the changes introduced to houses, as self-initiated actions or as official refurbishment programmes of Social Housing (SH). Concepts associated with the transformation phenomenon are flexibility, adaptability, metamorphosis, evolution, and resilience (GARREFA *et al*., 2021).

Housing studies in countries such as India and South Africa documented transformations in the 1980s. In the 1990s, several user-initiated housing transformations in Egypt, Bangladesh, and Brazil were recorded (REIS, 1995; KOWALTOWSKI; PINA, 1995; TIPPLE; AMEEN, 1999; TIPPLE, 2000). These studies discuss a variety of issues to improve living conditions by altering existing buildings, especially for SH. In general, such studies investigate the types of transformations made and their reasons. In this context, various terms – e.g., refurbishment, retrofit, renovation, improvements and upgrading - are used to describe such transformations. Herein, the terms 'upgrading' and 'transformation' are used.

The rationale for this study is the fact that, although housing transformations, most often initiated by users, generally aim to increase quality, both in technical terms and in terms of the dwellers' quality of life, this is not always proven in Post-Occupancy Evaluations (POEs). Making improvements in SH to increase the quality of life of low-income families' therefore needs guidance. The complexity of factors involved in housing transformations and upgrading processes should be investigated. With this in mind, the research questions underpinning investigations of upgrading in SH are:

(a) What are the main declared reasons for user-initiated transformations in SH in Brazil?

(b) What are the user-desired improvements for SH in Brazil?

(c) How do transformations affect dwellers' well-being and environmental comfort conditions?

(d) What are possible upgrading opportunities or actions to improve conditions that respond to dwellers' needs and desires?

Background

Most studies on official SH upgrading programmes have technical goals for compliance to mandatory protocols, primarily to increase energy efficiency and adapt housing to climate change (MERCADER-MOYANO; ESQUIVIAS; MUNTEAN, 2020; DOMINGUEZ-DELGADO; DOMÍNGUEZ-TORRES; DOMÍNGUEZ-TORRES, 2020; RAU *et al*., 2020; GAGLIANO *et al*., 2013). A technical upgrading process is complex, demanding a feasibility analysis, detailed design project, survey of costs, legislation, project approval, and various steps that include the building occupants during renovation activities (MORAES; QUELHAS, 2012).

Types of upgrading can be distinguished in terms of intervention categories and aims. Small or deeply invasive interventions are related to the extent of changes made. Specific technical interventions are related to maintenance necessities. Functional upgrading increases a building's performance over time and attends to new ways of living. Regulations may oblige governments to upgrade SH. Social dynamics increase obsolescence, which may cause further upgrading pressures. Housing commissions or government programmes, instigated with political agendas, are common top-down initiatives in developed countries (EUROPEAN..., 2016). Bottom-up user-instigated types of upgrading have various causes and objectives, which go beyond energy efficiency and thermal comfort (KARVONEN, 2013; DOMINGUEZ-DELGADO; DOMÍNGUEZ-TORRES; DOMÍNGUEZ-TORRES, 2020).

In developed countries, government-sponsored financial incentives boost upgrading activities to achieve higher sustainability ratings (EUROPEAN..., 2016). These transformations are often coupled to maintenance programmes and general improvement goals that may include the neighbourhood scale (POORTINGA *et al*., 2017). Other motivations for intervening in the existing housing stock are changes in comfort standards, impacts of new ways of life and the extension of the functional useful life of buildings (SOJKOVA *et al*., 2019; SYNNEFA *et al*., 2017; MUDGE; SAMAN, 2017; BREYSSE *et al*., 2011).

In many examples, construction maintenance demands are coupled to infrastructure improvements in public SH, such as kitchen and bathroom upgrading (TAUBE; HIROTA, 2017; ARAGÃO; HIROTA, 2016; BERR *et al*., 2015). Ways of living change over time and family structures are affected. There are technology changes, both from construction itself and in general. For instance, access to information technology (IT) has gradually enabled people to work from home. Increasingly, new activities performed in living spaces have

implications on SH design (LEDENT, 2016). Typical SH projects are based on small room dimensions, and therefore multicellular house designs no longer support such new functions (DE PARIS; LOPES, 2018). The ongoing pandemic currently emphasises this phenomenon.

Studies show that SH dwellers' discontent is related to functional space dimensions, and the number of rooms. Rooms are considered too small for different uses (TAUBE; HIROTA, 2014). Social distancing and isolation are hampered, as observed during the Covid-19 pandemic (BORTOLI; VILLA, 2020). Moreover, some recently available studies show that a lack of ventilation propagates the virus and that infection rates are higher in poorly designed and high-density housing developments (VILLELA, 2021; ORTIZ; ITARD; BLUYSSEN, 2020). Thermal comfort is often the main research consideration in POE and simulation studies, to assess if adequately heated and well-insulated homes in cold climates, for instance, increase user well-being (ORRELL *et al*., 2013; THOMSON *et al*., 2013).

Poor housing conditions, safety, and security issues can affect physical and cognitive health and create conflict (MUIANGA *et al*., 2021; ORTIZ; ITARD; BLUYSSEN, 2020; BARDHAN; SUNIKKA-BLANK; HAQUE, 2019; POORTINGA *et al*., 2017). Health and well-being, including harmonious family and community life, are important goals for official housing upgrading programmes (STANDEN *et al*., 2020). The location of projects and their design and construction elements, directly determine living conditions and the quality of life of segments of the population. Upgrading programmes can thus not only improve living conditions but also improve social development (MOURATIDIS, 2020).

The concept of quality of life is based on an individuals' well-being and extends to society as a whole (SWOPE; HERNÁNDEZ, 2019; MCKIM, 1997; FIELD, 1994). Housing essentially provides comfort, convenience, and safety. However, specific studies relating SH transformations to promote residents' well-being and health, are still scarce, especially in developing countries such as Brazil (SEVERO; DE GUIMARÃES; DELLARMELIN, 2021). Health is a vital impact factor on feelings of well-being, but other factors also play a part in a person's quality of life (THEOFILOU, 2013). These are employment, access to education, local commercial facilities, social services, conditions of accessibility, family relations, wealth, safety, freedom, and religious beliefs (MOURATIDIS, 2019; ORRELL *et al*., 2013).

Investigations with social goals are considered essential to address well-being and environmental comfort issues with specific social dividends (WATSON *et al*., 2016). Such studies investigate transformations to gain knowledge on well-being issues, and specific user needs and desires to support new housing projects' planning and design details (FERNANDES; FORMOSO; TZORTZOPOULOS-FAZENDA, 2018; TAUBE; HIROTA, 2017). These types of studies may be expanded to help programmes in decision-making on upgrading needs, attain positive results from transformations, avoid waste, and preserve dwellers' well-being over time (VECCHIA; KOLAREVIC, 2020; VILLA *et al*., 2017; BERR *et al*., 2015).

The main reasons for upgrading programmes are related to sustainable standards, given the challenges posed by climate change and the social consequence of fuel poverty in cold climates. Energy efficiency is a significant driver of official upgrading programmes in developed countries, for compliance with environmental regulations (INTERGOVERNMENTAL..., 2018). Proactive energy efficiency and emission goals have user health and well-being dividends (SEMPRINI *et al*., 2017; ELSHARKAWY; RUTHERFORD, 2015, 2018; SOARES *et al*., 2016; PERETTI *et al*., 2015).

Non-economic arguments for transforming existing SH through careful and impact-sensitive processes should be explored beyond energy efficiency (STENBERG, 2018). Introducing improvements to SH neighbourhoods has been shown to alleviate social tensions (MOURATIDIS, 2020; MORAES; QUELHAS, 2012). Data also shows that upgrading the existing stock in many countries can indirectly alleviate housing deficits (BUCKLEY; KALLERGIS; WAINER, 2016; MASTRODI; ZACCARA, 2016). However, Hochstenbach (2015) warns that top-down programmes need careful planning to avoid social exclusions, gentrification, and increased polarisation between the rich and poor.

In developing countries, transformations of SH are mainly carried out through individual initiatives, motivated by predominantly poor design and construction quality of the original building (TRIANA; LAMBERTS; SASSI, 2018; SOARES *et al*., 2014; KOWALTOWSKI; GRANJA, 2011). In these countries, housing transformations take different forms and occur both in self-built and public SH (KOWALTOWSKI *et al*., 2021).

The self-building of houses is common in these countries, mainly due to large housing deficits and the high cost of home acquisition through the free market (KOWALTOWSKI; PINA, 1995). The basic need for shelter makes people act on their own, by building a home for themselves on acquired or, in many cases, illegally occupied land. Such self-built constructions are built over time, with multiple, often continuous

changes introduced, which can also be considered transformations (TIPPLE, 2000; KOWALTOWSKI; PINA, 1995).

In developing countries, users also transform public SH without the support of official programmes. In many cases, the changes made are not compliant with regulations. Users give specific reasons for intervening in their houses. Most people add space, considering their homes too small (NASCIMENTO *et al*., 2015; MIRON; FORMOSO, 2010). In the 1990s, comparisons of self-built houses and SH projects showed a 30% difference in size, whereby SH dwellers intervene to gain additional space (KOWALTOWSKI; PINA, 1995).

In Brazil, government housing programmes focus on reducing the housing deficit with political and economic goals. New constructions are prioritised in such agendas (MASTRODI; ZACCARA, 2016). Many POE studies of the large housing programmes called "Minha Casa Minha Vida" (MCMV, *My House My Life*) show that changes are introduced by users, mostly in projects based on single-family houses (BORTOLI; VILLA, 2020; COSTA, 2015). Although there are many restrictions on changing the unit's space offered by the MCMV programme, residents will nevertheless introduce adaptations and manage to print the most diverse marks of individualization on their homes (NASCIMENTO *et al*., 2015). Many of these POE studies point out that environmental comfort conditions are negatively affected by such user-initiated, often well-intentioned transformations (BORTOLI; VILLA, 2020; KOWALTOWSKI; PINA, 1995). Additions may block the natural light and ventilation of existing spaces.

At the same time, interventions may be positive and innovative. Some studies showed the use of reused building materials or the creation of ventilation and natural lighting shafts between rooms. This demonstrates the potential for engaging this population in evaluating their home environments and participating in upgrading programmes when additional technical support is offered (BORTOLI; VILLA, 2020; HORONGOSO; BOGO, 2018).

A constant desire for more security and aesthetic improvements exists in Brazil, such as distinguishing one's house from others or simply promoting change in appearance, exchanging the floor material, upgrading and updating installations of kitchens and bathrooms (NASCIMENTO *et al*., 2015). These desires induce, in some cases, quite extensive changes to houses (BORTOLI; VILLA, 2020). As security is the most crucial issue (KOWALTOWSKI; GRANJA, 2011), perimeter walls are built, and controlled entrance gates are installed. Such interventions demand new installations such as interphones, affecting shared utility bills in apartment buildings and houses in condominium-type neighbourhoods (SOARES *et al*., 2016; NASCIMENTO *et al*., 2015).

Construction waste is associated with transformation actions. A cycle whereby building, demolishing, and rebuilding takes place is evident in many of the cases studied (GARREFA *et al*., 2021; HORONGOSO; BOGO, 2018; JORGE *et al*., 2017; SOARES *et al*., 2014). For multi-storey, multifamily SH, the desire for more space also exists, not able to be fulfilled, except for ground floor apartments in special cases. There are added desires, such as quiet living conditions, access to nature through green areas and landscaping, and parking places, as attested by users of apartments and single-family house owners in SH projects in Brazil (KOWALTOWSKI; GRANJA, 2011). In multi-family SH, such additions are predominantly on the ground floor, giving these apartment occupants opportunities to add private indoor space to the detriment of the whole project's open public areas (REIS, 1995). Transformations that encroach on or affect public land and its use often cause conflict. Their planning and control need technical guidance and social assistance to measure the implications of such actions and how to mitigate them.

Although studies have identified quality problems in SH, the end-users' perception of the final product is essential to provide feedback for design and construction stages (BERR *et al*., 2015). A participatory planning and design process is advocated to include user needs and desires and avoid a further cycle of user-initiated unstructured and unsupported improvement interventions.

Bearing this in mind, the analysis of end-user demands based on transformation studies can help capture residents' desires. Transferring residents' needs and desires to products throughout the planning and design process may be facilitated, and priorities for official upgrading projects can be established (ARAGÃO; HIROTA, 2016).

Method

A Systematic Literature Review (SLR) method was used in this study (CAHYO, 2021; OKOLI, 2015). However, the analysis goes beyond a summary of the data, aiming to make guidelines for SH upgrading programs based on evidence from the literature (XIAO; WATSON, 2019).

Sample description and analysis

A panorama of results was generated through publications found in the databases used. Specific search strings were applied to four databases: Science direct, Scopus, Scielo, and Web of Science (Figure 1). Our study combined a set of terms in the search strings to ensure that the literature on the most common SH programme in Brazil would be included, as follows: upgrading, social housing, and its variations, as well as the term "*minha casa minha vida*" or "my house my life" in English.

Titles and abstracts of selected studies were analysed to create a panorama of the research. From 935 studies, 644 studies not matching the main issues (upgrading and SH, and its variations) were discarded after reading titles and abstracts. Moreover, 119 duplicated studies were removed. Another analysis involved reading all the texts of the remaining papers, and a further 33 documents were discarded. Thirteen studies were not accessible and therefore removed. Finally, 8 studies were added using the Snowballing Technique (ST). ST is a method used to include pertinent papers in the review not identified previously (KAUR; CHAHAL; SAINI, 2020; BARAT *et al*., 2017), using the selected documents' reference list or citations (WOHLIN, 2014).

A preliminary analysis of these 134 papers was refined to define the final sample. This analysis identified 87 studies on SH programmes considered irrelevant for the study, as they focused on specific SH issues not matching with the topics of transformations and upgrading. The final sample of papers for our analysis comprised 47 papers (Figure 2).

This sample was scrutinised to identify the types of transformations and improvements that occur in Brazilian SH and to understand how these upgrading projects relate to the desires and well-being needs of residents. The final studies accepted and grouped by their main issue are presented in Figure 2. A bibliometric analysis of our survey indicates three main upgrading fronts within the SH literature:

(a) layout, functionality, and post-occupancy evaluations;

(b) social and economic issues; and

(c) sustainability issues (environmental comfort and sustainability upgrading actions and strategies and energy efficiency methods).

Figure 1 - **SLR structure of documents analysis**

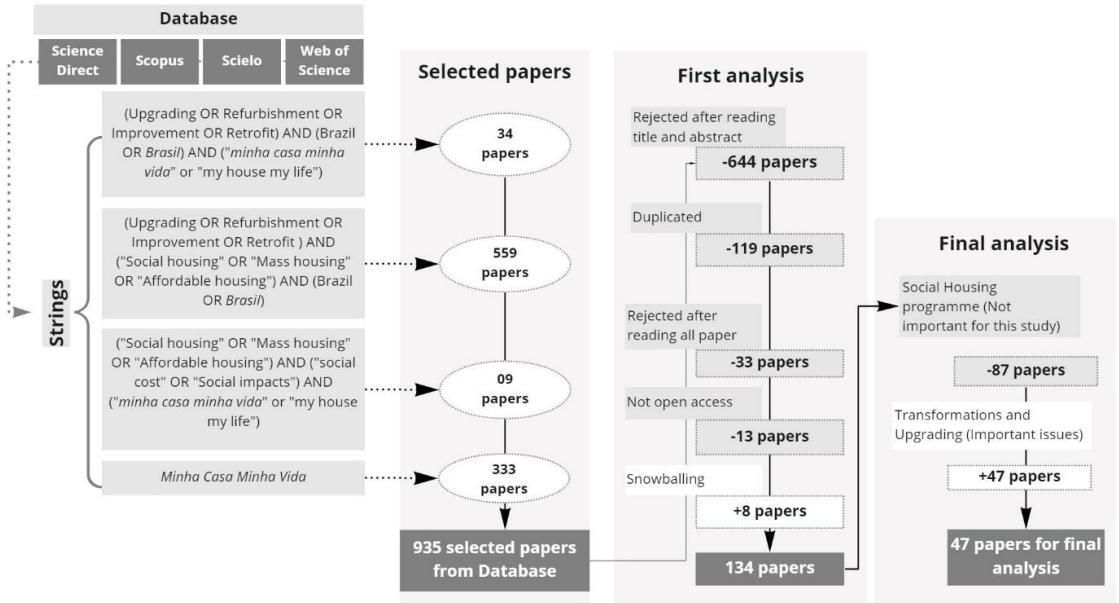
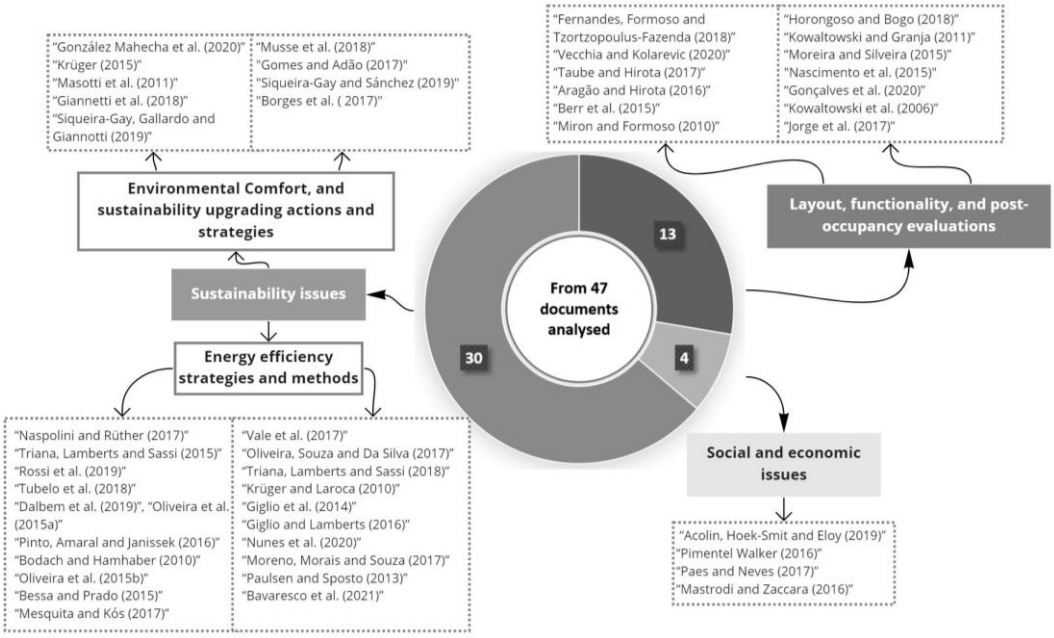


Figure 2 - **Bibliometrics of topics found in the research analysed**



Results and discussion

In this section, the main issues of SH transformations are presented. The results are discussed, according to the three identified fronts:

(a) layout, functionality, and post-occupancy evaluations;

(b) social and economic issues; and

(c) sustainability issues (environmental comfort and sustainability upgrading actions and strategies and energy efficiency methods).

Layout, functionality, and post-occupancy evaluations

The POE studies of SH developments identified dwellers' needs and desires concerning functional issues and internal layouts in blocks of flats (multi-family), and single-family houses. Many investigations indicate that such studies have little impact on new developments; thus, errors are perpetuated, creating discontent and inducing transformations (TAUBE; HIROTA, 2017; BERR *et al*., 2015). Requirement checking methods are indicated to ensure that SH models are revised in terms of minimum dimensions for domestic functions (FERNANDES; FORMOSO; TZORTZOPOULOS-FAZENDA, 2018). Patterns of user complaints indicate potential paths for official upgrading actions (Figure 3).

Construction defects are perceived, and other technical issues are strongly associated with environmental comfort. People complain about small window openings for natural light and ventilation, both in multi-family buildings and single-family houses. Noise interference from neighbours is a frequent problem (BERR *et al*., 2015). Such issues may affect people's health (physical and mental), and therefore their well-being (MOURATIDIS, 2020).

Poorly ventilated spaces can cause respiratory diseases. However, environmental comfort and associated health issues are less prevalent reasons for upgrading by owners (THOMSON *et al*., 2013). Functional convenience is a stronger driver to improve SH, and public SH owners primarily transform their homes to gain additional space in single-family houses. Private parking spaces are other frequent additions in multi-family building complexes. Desired design changes are often hampered by a lack of planning for expansions and minimum dimensional standards. A lack of foresight, i.e., a commitment by government programmes to housing quality, lack of design flexibility, and adaptability are also long-standing criticisms of SH programmes (HORONGOSO; BOGO, 2018; NOWAKOWSKI, 2020).

Discontent with the landscaping of public areas of SH estates is prevalent in multi-story SH projects. Although users value vegetation, user-initiated actions for planting in public areas are rare, mainly due to

weak community cohesion (ARAGÃO; HIROTA, 2016; KOWALTOWSKI *et al*., 2006). A major complaint continues to be the lack of security (KOWALTOWSKI; GRANJA, 2011), and the desire to have protective elements such as estate perimeter walls, guarded entrance gates, surveillance cameras, and bars on windows (MOREIRA; SILVEIRA, 2015; NASCIMENTO *et al*., 2015). This occurs in both multi-family buildings and single-family houses in condominium structured neighbourhoods.

From the occupants' perspective, main expectations shed light on upgrading measures to be prioritised (Figure 4). Many transformations respond to desires to individualise the home through decorative elements. Users change finishing and front doors and windows, and exterior wall colours in single-family houses. In Brazil, this trend reaffirms the psychological need for identity.

Figure 3 - **User complaint element descriptions**

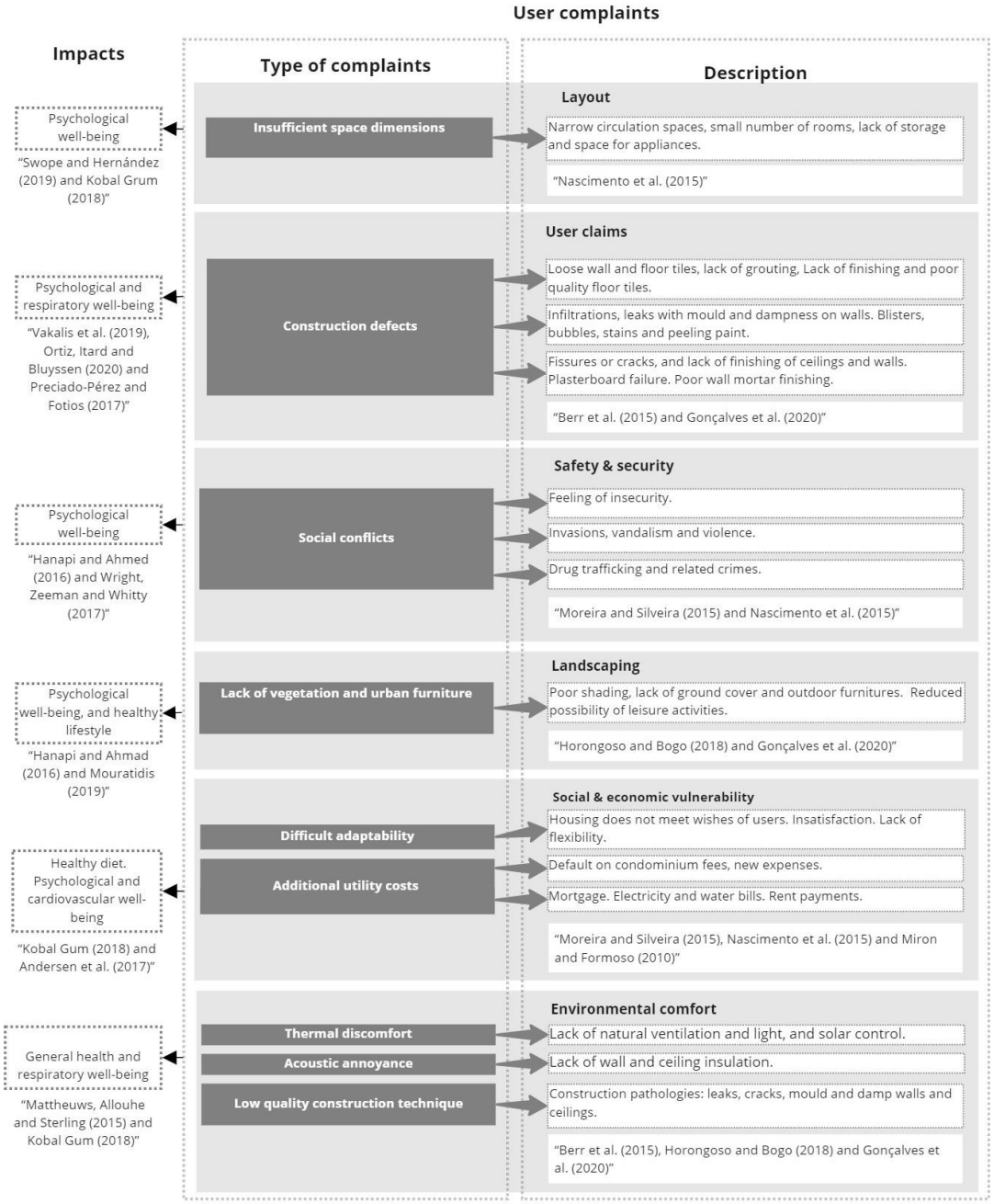
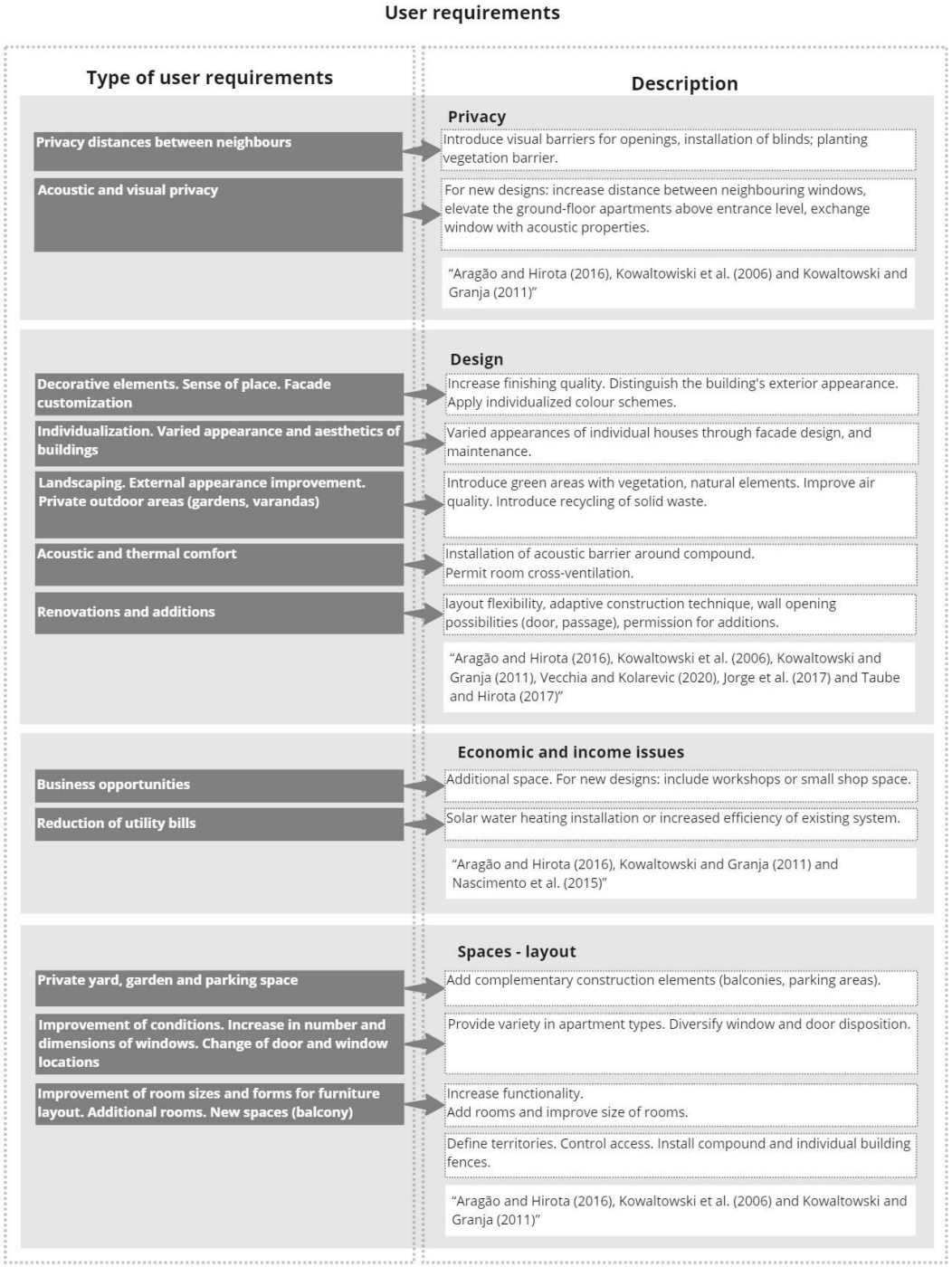


Figure 4 – **User requirements concerning upgrading interventions in SH**



Transformations of multi-family housing show that users are enterprising with their adaptations. Small shops and workshops are installed in dwellings, even in multi-storey buildings. In addition, trailers are placed on the streets, comprising a diversity of commercial activities (ARAGÃO; HIROTA, 2016). This phenomenon encroaches on public space and may cause general deterioration to a neighbourhood, although permitting better access to services (KOWALTOWSKI; GRANJA, 2011).

Low-income populations are affected by the lack of consistent policies, as well as severe budget constraints (Figure 5). Policymakers often face a trade-off between quantity and quality to meet a housing shortage (GONZÁLEZ MAHECHA *et al*., 2020). Once units are occupied, recurrent costs with, for instance, mortgage and utility bills may reduce potential upgrading interventions (MOREIRA; SILVEIRA, 2015; NASCIMENTO *et al*., 2015; MIRON; FORMOSO, 2010). Generally, upgradings increase the value of

buildings and give homeowners incentives to introduce improvements once mortgages are fully paid. However, with the lowest income groups, any extra expenses are prohibitive.

Social and economic issues

The urban isolation of SH estates is criticised as it reduces the potential for extra income opportunities (KOWALTOWSKI et al., 2018). As shown in Figure 5, social and economic issues are impacted by the location of most SH estates, at the urban fringes (MASTRODI; ZACCARA, 2016).

Families find themselves located far from their employment and social networks, which causes discontent (ACOLIN; HOEK-SMIT; ELOY, 2019; BORGES *et al*., 2017). As location cannot be changed, upgrading actions should be implemented to improve neighbourhoods through infrastructure, parks, schools, and services (GONÇALVES *et al*., 2020; ACOLIN; HOEK-SMIT; ELOY, 2019). However, erroneous identification of demands through socioeconomic surveys seems to be the major obstacle to implementing urban renewal programmes (PAES; NEVES, 2017).

Sustainability issues (environmental comfort and sustainability upgrading actions and strategies and energy efficiency methods)

SH programmes should consider environmental comfort and sustainability in the design and implementation phases of a project, including related economic issues (SIQUEIRA-GAY; SÁNCHEZ, 2019; GIANNETTI *et al*., 2018). Figure 6 shows strategies for upgrading, actions to improve environmental comfort and the overall sustainability of SH estates.

Correct constructive systems are essential to provide thermal comfort and to meet Sustainable Development Goals (SDG) concerning energy consumption and greenhouse gas (GHG) emissions, especially for large SH estates (GONZÁLEZ MAHECHA *et al*., 2020). However, SH in Brazil mostly uses a low-standard construction system, with few concerns for location and bioclimatic zones. Heat discomfort is felt in the summer, and in some regions, cold discomfort can occur in winter (KRÜGER, 2015). Moreover, damp conditions and rain infiltration are common. Most SH units are poorly lit and ventilated (MASOTTI *et al*., 2011). In many cases, upgrading is urgent to improve thermal and comfort conditions and raise sustainability standards (GOMES; ADÃO, 2017; MASOTTI *et al*., 2011). Achieving better thermal conditions may reduce the need for air conditioning, a major consideration in Brazil, where hot climates prevail. The proliferation of air conditioning has negative impacts on energy efficiency. The very poor will continue to live in substandard thermal conditions and for those low-income families that acquire air conditioning spending power on food and education is reduced through increased electricity bills.

Energy efficiency is a significant focus of SH studies carried out in Brazil as shown by the many references in Figure 7. These studies are based on simulations with recommendations for future upgrading programmes. Strategies and models to achieve thermal and energy performance are presented.

Meta-models, simulations (ROSSI *et al*., 2019; KRÜGER; LAROCA, 2010), laws, photovoltaic panels, and solar water heating are the main strategies tested to enhance energy efficiency in SH (PINTO; AMARAL; JANISSEK, 2016; VALE *et al*., 2017; TRIANA; LAMBERTS; SASSI, 2015, 2018; OLIVEIRA; SOUZA; DA SILVA, 2017; MORENO; MORAIS; SOUZA, 2017; NUNES *et al*., 2020; BAVARESCO *et al*., 2021). Although those strategies contribute to the general goals of sustainability issues and climate change control, most of them require a high initial investment to be implemented. Solar water heating excluded in developing countries, such as Brazil, demonstrate fewer opportunities to include those strategies (NASPOLINI; RÜTHER, 2017; BESSA; PRADO, 2015).

Overall discussions of research results

SH POE studies in Brazil show varied user quality of life impacts of housing transformations. Both for multi-family and single-family housing, reasons to change the home environment relate to space dimensions and the small number of rooms in these housing types. Maintenance and upgrading of bathroom and kitchen fixtures is also a constant necessity and desire. Importance should be given to consider different family compositions, as non-traditional setups are becoming more common in Brazil.

Due to high criminality rates and a specific cultural context concerning security in Brazil, perimeter fences and walls of housing complexes are considered upgrading priority. A lack of well landscaped green spaces for leisure activities impact SH populations by curtailing physical activities and positive social encounters.

Moreover, additional space for income opportunities creating small local businesses is a strong motive for transformations.

Figure 5 – **Identification of social and economic issues**

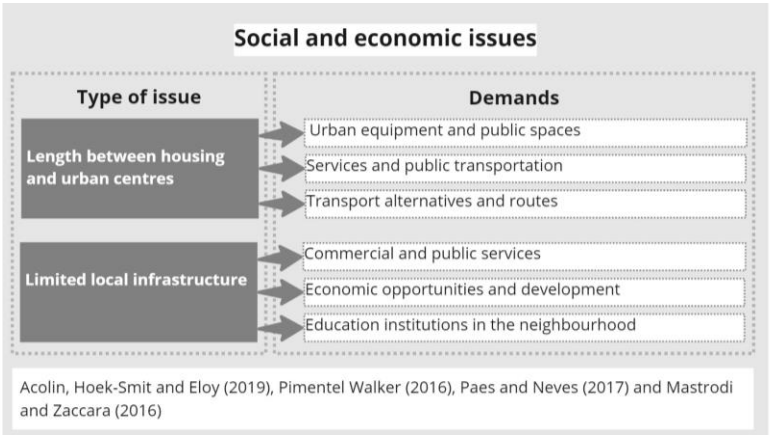


Figure 6 – **Environmental comfort and sustainability upgrading actions and strategies**

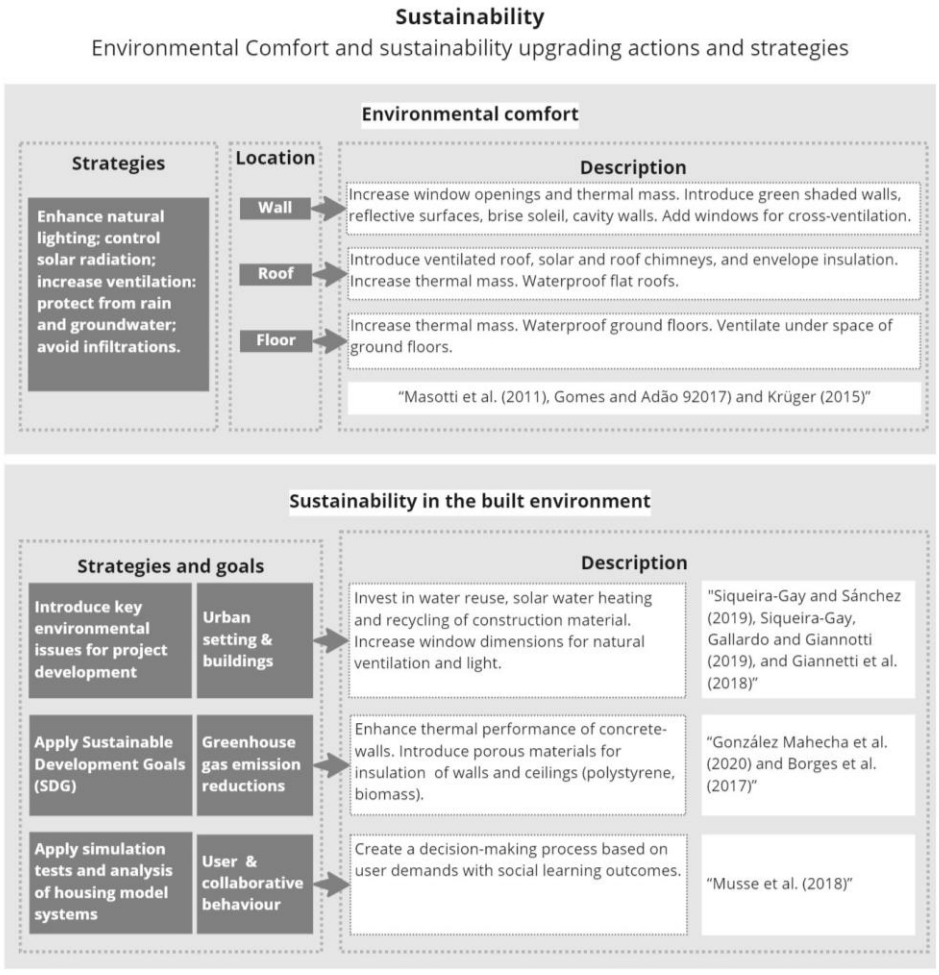
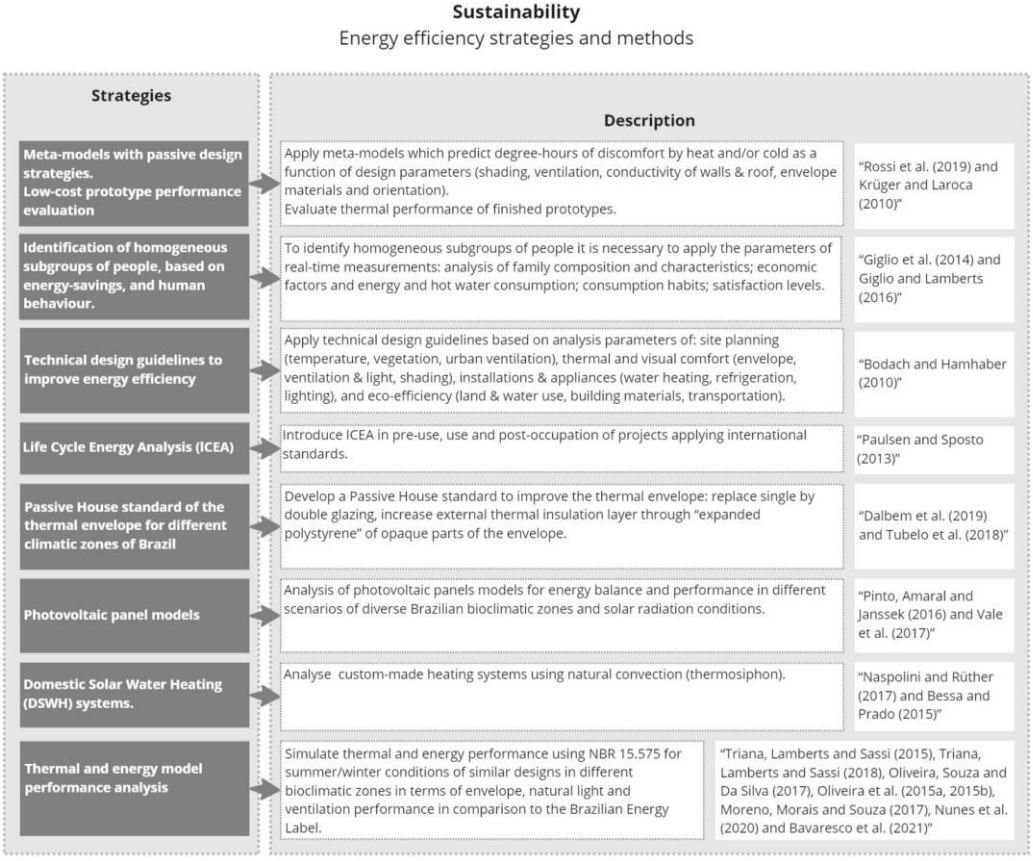


Figure 7 – **Energy efficiency strategies and methods**



People desire shading and rain protection for their cars. In multi-family housing complexes parking areas are often roofed on an individual basis. A collective solution, although technically more rational and more economic, is rarely adopted due to a lack of a community spirit and difficulties to gain a consensus on interventions that impact individual families financially.

Outdoor public path lighting is mostly absent and should be installed with a low consumption performance system. Other interventions, such as Internet connection, often not part of typical building upgrading processes, may enhance job and education opportunities, and should be promoted. IT investments are a priority to support ways of living today. Moreover, on a very different level, solid waste services need improving in most SH developments.

Urban issues affect the well-being and quality of life of SH dwellers. Demands for infrastructure, services and equipment in the neighbourhood are recurrent requests. Improvements in the spatial quality are fundamental elements to be considered in upgrading housing projects.

Most Brazilian SH, for the lowest-income population, is located in monofunctional zones on city outskirts. Inadequate urban mobility is a serious problem affecting the quality of life of SH dwellers with fewer job opportunities and stress due to long daily journeys to reach work destinations, services, as well as educational and cultural institutions. When upgrading programmes are put into place, the psychological well-being of users' needs to be included in quality of life issues.

Most studies indicate the desire to live in a quiet place, thus noise control measures should be put into place. These may involve, in some cases, substantial transformations. Acoustic highway barriers are required in special cases, ceiling panels may need to be installed in apartments, and windows and doors may need to be changed.

Although sustainability is less considered in the current scenario of Brazilian SH production, this issue demands critical analysis and actions for improvements. In relation to this, energy efficiency is an important factor, considering the impacts of climate change.

Housing improvement actions

Different actions should guide improvements in SH to improve dwellers´ quality of life. Functionality, environmental psychology, environmental comfort, housing communication systems and infrastructure, sustainability, and social issues are the main topics of actions for housing upgrading detected by our SLR. Table 1 presents specific actions indicated to improve housing conditions. However, the active participation of dwellers is fundamental to achieve positive results as context is crucial to successful upgrading programmes.

Table 1 – **Actions to guide improvements and achieve housing transformations (Continues...)**

Issue	Categories	Description	Authors
Functionality and environmental psychology	Privacy: *Visual* *Private spaces* *Acoustic*	Use window shades or garden walls for privacy. Introduce private gardens and outside areas. Install soundproof windows. Add acoustic insulation to the walls, floor, and roof.	Aragão and Hirota (2016), Nascimento *et al*. (2015) and Kowaltowski and Granja (2011)
	Ergonomic and space	Provide adaptable spaces: movable walls and movable lightweight partition walls. Improve space dimensions and functionalities according to user desires.	Nowakowski (2020), Horongoso and Bogo (2018) and Silva and Fleury e Silva (2013)
	Territoriality	Flexible modifications or transformations of space functionality. Provide variability of appearance and aesthetics of the unit through individualised design.	Mesquita and Kós (2017), Nascimento *et al*. (2015), Kowaltowski *et al*. (2006)
	Crowding	Introduce a functional furniture layout. Provide multipurpose environments. Ensure privacy needs of dwellers and implications of local cultural requirements.	Swope and Hernández (2019) and Fernandes, Formoso and Tzortzopoulos-Fazenda (2018) and Giglio *et al*. (2014)
	Leisure and visibility	Provide: green areas, back yards, good visualisation of leisure spaces for child supervision (windows, openings), natural recreational spaces (yard, landscaping), places for pets, and private plants.	Mouratidis (2019), Ortiz and Johannes (2018), Wright, Zeeman and Whitty (2017) and Hanapi and Ahmad (2016)
	Aesthetics	Improve housing design and performance, break with monotony. Change the architectural expression, and building design/layout.	Opania (2019) and Kowaltowski *et al*. (2006)
	Structural elements	Improve the infrastructure system (installations), structural integrity, and functionality. Replace outdated deficient infrastructure. Ensure easy maintenance.	Andersen *et al*. (2017), Hanapi and Ahmad (2016), Soares *et al*. (2016) and Kowaltowski *et al*. (2006)

Table 1 - **Actions to guide improvements and achieve housing transformations (continued)**

Issue	Categories	Description	Authors
Environmental comfort	Thermal comfort	Improve insulation (ceiling, floor, and walls) and weatherproofing. Replace the building envelope. Adjust shading elements or panels to specific sun orientations. Improve green spaces.	Rau *et al*. (2020), Mercader-Moyano *et al*. (2020), González Mahecha *et al*. (2020), Sojkova *et al*. (2019) and Mesquita and Kós (2017)
	Indoor air quality and natural light	Increase openable window dimensions for natural ventilation and cross-ventilation. Improve building sun orientation. Remove damp spots and mould and increase ventilation. Add mechanical ventilation. Improve windows for daylight (larger openings).	Siqueira-Gay and Sánchez (2019), Siqueira-Gay, Gallardo and Giannotti (2019), Giannetti *et al*. (2018) and Krüger (2015)
	Acoustic comfort	Change floor covering. Improve position of openings. Introduce insulation in walls. Apply floor finishing materials with acoustic performance.	Santos *et al*. (2021), Gramez, Ouis and Belhamel (2021) and Ortiz, Itard and Bluyssen (2020)
Communication system	Control and security system	Install video monitoring services. Provide controlled housing entrances: security cabins, interphone. Control vandalism. Improve safety factors of buildings.	Soares *et al*. (2016), Aragão and Hirota (2016), Nascimento *et al*. (2015) and Kowaltowski and Granja (2011)
	IT system	Enable digital access and remote communication providing equipment and internet systems. Provide Internet access to facilitate home-office and home-schooling activities and telemedicine access.	Wright, Zeeman and Whitty (2017)
Sustainability	Installations: water and energy efficiency	Introduce envelope insulation: smart (Photocatalytic) coating. Introduce thermal insulation: sealing systems. Improve hydraulic functionality: maintenance and exchange hydraulic installation, improve sewage and drainage systems, introduce rainwater harvesting systems.	Rau *et al*. (2020), Dominguez-Delgado *et al*. (2020), Dalbem *et al*. (2019), Tubelo *et al*. (2018), Synnefa *et al*. (2017) and Mesquita and Kós (2017)
	Consumption efficiency	Install solar water heaters and water reuse systems. Add / or increase water reservoirs. Avoid leaks and waste. Install shading devices for windows and increase thermal comfort.	Naspolini and Rüther (2017), Vale *et al*. (2017), Preciado-Pérez and Fotios (2017) and Bessa and Prado (2015)
	Waste treatment	Provide adequate solid waste services. Introduce solid waste bins. Organise the separation of organic and recyclable trash. Connect with existing community re-use networks.	Ortiz, Itard and Bluyssen (2020), Vakalis *et al*. (2019) and Soares *et al*. (2016)
Social issues: Urban and Neighbourhood	Public spaces. Infrastructure and mobility. Public and private services	Introduce local amenities. Promote access to collective and common goods, services, and public infrastructure of urban centres. Improve access to education, health, transport, jobs, and decent housing.	Mouratidis (2019), Acolin, Hoek-Smit and Eloy (2019), Moreira and Silveira (2015) and Kobal Grum (2018)

Conclusions

Our analysis evaluated prevailing types of transformations occurring in SH in Brazil. The reasons for changes and desired improvements to homes are seen as opportunities for upgrading. The prevalent comfort, privacy, security, design, layout and economic problems outlined here directly affect the well-being of individuals. Many user-initiated transformations of houses do not always resolve problems, and can affect the health of dwellers negatively. Especially for single family houses, thermal and natural lighting comfort conditions are reduced with new additions that block original openings. In apartment buildings, environmental comfort upgrading needs are mainly associated with noise problems which are difficult to solve, demanding behavioural as well as design changes.

Upgrading actions, to improve SH sustainability and energy efficiency, are outlined in many studies through simulations. These studies recommend strategies to mitigate problems. Better ventilation and natural lighting through larger window openings are indicated. Enhanced thermal performance of walls through insulation and shading can also be achieved, requiring in-depth and costly upgrading. For energy efficiency, many studies present strategies on how to intervene, and monitoring methods are outlined.

This study has shown that upgrading of SH is not only about technical issues but also touches on subjective details. To quote the latest Pritzker Prize winners, the French Architects Anne Lacaton and Jean-Philippe Vassal, "Buildings are beautiful when people feel well in them" and to achieve this, the built environment needs to be "repurposed, reinvented, reinvigorated". An urgent question arises on how this can be achieved efficiently, whilst avoiding the repetitions of past errors in SH. SH upgrading needs to involve users and other stakeholders through participatory methods and co-designed solutions. The promotion of social innovations are seen as a means to increase people's perception of the environment and their self-involvement in introducing positive change. The often intricate and conflictive relationships involved must be mitigated so that stakeholders partnering in SH upgrades are also engaged to design, finance, and implement the outcomes needed to effectively make a difference in people's well-being and lives.

New ways-of-living increase the necessity for upgrading SH based on old models. The ongoing pandemic, which heavily hit Brazil, makes it dramatically evident that additional and specific actions are fundamental for SH and its urban areas. The pandemic affects families´ ways of living and habits. In most cases, space is inadequate for social distancing and generally lacks proper functional arrangements for a family to stay at home. Social distancing measures have induced many families to transform the physical environment for daily work, schooling, and isolation needs. Leisure and other individual needs have also induced home alterations by users, although for SH with some difficulties (VILLELA, 2021).

Thus, for future studies, we will concentrate on the issues of new ways of living and post Covid-19 pandemic upgrading needs for SH. More research is also necessary to accurately specify priority building construction details to provide quality living conditions for low-income families.

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Funding

The authors would like to thank the *Fundação de Amparo à Pesquisa do Estado de São Paulo* - FAPESP [Processes #2020/06462-0, #2019/02240-5], and CNPQ [Processes #311146/2020-1 (ADG); #302080/2017-1 (DCCKK); #306048/2018-3 (VGS)] the national research funding agency for the generous funding support.

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Ambiente Construído
Revista da Associação Nacional de Tecnologia do Ambiente Construído
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