Drivers and Challenges for Implementing Sustainability-oriented Upgrading in Social Housing in Brazil

L H Vasconcellos 1, D Kowaltowski 1, V Gomes 1

1 University of Campinas, School of Civil Engineering and Architecture and Urbanism, Rua Saturnino de Brito, nº 224, Cidade Universitária Zeferino Vaz. CEP: 13083-889 - Campinas - São Paulo, Brazil
vangomes@unicamp.br

Abstract. Social housing (SH) development is, in general, triggered by policies and regulations, which stimulate interventions, create financing mechanisms, and designate agents conducive to retrofit processes. European directives for energy efficiency and the recent call for a 'retrofit wave' have an evident influence. In Brazil, delivery and management of SH are based on the public offer of housing units and their immediate ownership transfer. National or state housing agencies are responsible for basic maintenance for five years, but other post-delivery interventions depend exclusively on the effort and expenses of the occupant. SH budgets leave little or no margin for extra spending and bringing SH to international sustainability standards is yet not mandatory. The issues that arise to implement upgrading in this context are therefore related to the following questions: What are the priority actions in upgrading processes? What type of financing would be required or is available? What is the project execution model and who are the stakeholders involved? This article focuses on the issue of prioritization of actions for upgrading SH. A systematic literature review examined reported sustainability-related housing improvements. A critical review of a Brazilian building label and two international sustainability assessment methods then supported ranking the upgrading actions according to the relevance assigned in their respective contexts. Finally, a panel of construction professionals provided insights regarding the technical feasibility and intrusiveness of their implementation in both single- and multi-family SH projects. Findings show that minor upgrading actions, such as changing hydraulic or electrical fixtures or landscaping, usually do not cost more than implementing them from the outcome and are equally applicable to single- and multi-family SH projects. But, when high-level (deep upgrading) interventions are on the table, costs rapidly increase due to the need to substantially change existing systems or supporting structures, which makes them often financially and/or technically unfeasible.

Keywords: social housing, sustainability, upgrading, drivers, challenges, prioritization

1. Introduction
Internationally, sustainability of existing buildings has come to the forefront of discussions over the last decade. The need to reduce energy demands has triggered energy efficiency policies. In Europe, we find general Directives [4, 5], for instance, those with specific domestic scopes in France, the UK, and Italy [6, 12]. Some countries have developed regulations and policies over the years with funding lines to encourage the adoption of sustainable practices in the building sector and in social housing (SH). Most
often, such drivers are built upon collaborative SH models that facilitate the dialogue and settings for carrying out upgrading interventions.

Brazil shows a clear gap in this regard. Sustainability measures are, in general, currently ignored, even those with low or no cost. More fundamentally, the SH delivery and management model is based on the public offer of housing units and ownership transfer upon their delivery. This breaks the responsibility linkage for the existing large SH stock built on low budgets and minimum construction standards.

Public funding, in Brazil, is directed to new housing, to fulfil social and political goals, neglecting the need to retrofit the existing housing stock and the fact that the SH population is unable to cope with upgrading costs on their own. This combination makes it difficult to establish a proper dialogue between the multiple owners involved and other stakeholders necessary to fund and execute upgrading interventions.

2. **Context and background research**

The pressing housing demand, especially for low-income families, induced the Brazilian Federal Government in 2009 to create the program “Minha casa, Minha vida – MCMV” (“My home, My life”), to facilitate access to housing. However, due to the urgency for massive housing delivery, SH projects are based on standardized low-cost models throughout the country, ignoring regional characteristics and their specific climates. This leads to low-quality buildings that in many ways do not meet user needs, especially regarding functional and thermal comfort [5, 11]. In this context, users often intervene on their own, especially in SH developments based on single-family houses. Transformations are often substantial to gain more indoor space. Many houses increase up to 30% in area, in relation to the original house size, which provides 35 sq. meters of functional indoor space [9, 8]. The user-introduced changes, for the most part, are not approved by local authorities and, although increasing the functional area of homes, often reduce environmental comfort conditions [10]

Retrofit programs should have the potential to circumvent low-quality situations. In the case of Brazil, upgrading programs SH developments face additional challenges to the diverse conditions that present themselves. Intervening in this context and choosing the best option from the numerous technologies, components, and materials available is therefore important, and if Brazil is to adopt retrofit programs in the near future, it is essential to present a pallet of options for efficient application [2].

Although some standards establish minimum performance criteria applicable to newly designed SH [4], no requirements or metrics for assessing the environmental, economic, and social sustainability of the existing SH stock exist [1]. As the massive SH deficit is often tackled through large development delivery, assessments need to reach different scales, starting at the unit level and going up to the neighbourhood scale.

A large SH stock exists throughout the country, which needs actions to bring these projects to minimum sustainability standards, especially given climate change protocols. Public funding is mainly available for new housing delivery and the low purchasing power of the population groups, served by SH, makes housing upgrading actions unaffordable. This combination leads to a deadlock and innovative, out-of-the-box approaches must therefore be explored.

The research herein described supports the uVITAL project, a transatlantic social innovation collaboration. The research prospects innovative SH upgrading that focus on the aspects most valued by users according to living labs (LLs) developed in Brazil, Germany, The Netherlands, and the United Kingdom.

In upgrading or retrofitting processes not only user values must be included but also mandated requirements and economic and larger social issues cannot be ignored. The concept of LLs is based on the idea of creating a platform to join different viewpoints and goals of stakeholders involved in complex problem-solving where conflict and mistrust may occur [14, 3].

---

1 User-Valued Innovations for Social Housing Upgrading through Trans-Atlantic Living Labs, funded by the Trans-Atlantic Platform "Social Innovation".
Within uVITAL’s overarching goals, three main scopes emerged for designing the Brazilian LL: What type of upgrading should be prioritized? What type of financing would be required or is available? and What delivery model and stakeholders would be involved? To contribute to the answers to these questions, we focus here on the prioritization of SH sustainability upgrading actions and classify them according to their potential for implementation in the Brazilian context.

The Brazilian case study is a small housing development, called Quilombo, of 92 two-storey row houses and 4 single-floor accessible houses along two cul-de-sac streets, as shown in Figure 1. Many transformations occurred in the 10 years since the families moved into these houses. Although the local housing association COHAB-Campinas has a social assistance service, these changes did not have technical help or approval from the municipal authorities.

![Figure 1. Brazilian case study “Quilombo” in the City of Campinas, Brazil. Original projects in 2013 and 2022 street view with user-initiated additions and alterations.](image)

General background information was collected to contextualize the research. Data triangulation was performed (varied investigators and data collection modes). Information collected from the literature on housing upgrading or refurbishment and from reflexive interviews with users and public agents was analysed and complemented by brainstorming sessions by the research team [13]. The pandemic impacted participants' engagement in interviews and responses to questionnaires, and forced adjustment of research and investigation tools originally planned. Our investigation to date provides a general background and some priorities could be listed.

The brainstorming sessions, based on the literature search, organized upgrading actions according to eight topics - health, economics, sustainability and environmental issues, social issues, behaviour and well-being, infrastructure, rehabilitation and maintenance, and innovation – for which nine action issues were identified for the research context.

Firstly, functionality addresses questions of space standards and layout, while environmental psychology deals with privacy, personal space, territoriality, crowding and the perception of security. Leisure and recreation deal with urban and green area design to promote outdoor activities. Aesthetics of housing address the design concept and maintenance of buildings and the surrounding area. Environmental comfort covers insulation of buildings, ventilation, sun protection, window type and location, air quality, toxic materials, acoustic floor and wall insulation, and silence rules. New ways-of-living need consideration impacting unit layouts. Communication infrastructure is of major importance in society today, with the need for digital access to share information. Security and safety include access control, fire and accident safety, as well as security equipment, such as cameras. Sustainability addresses energy efficiency through thermal exterior building skins and reflective surfaces, shading devices, sensors for thermal comfort, new furnaces, solar and photovoltaic panels, replacement of lamps and upgrading of electric installations. Efficient use of water depends on the replacement and maintenance of faucets and hydraulic installations and a larger capacity of water storage containers. Finally, structural safety and maintenance are essential for the unit and building scale, and should include roof leaks, and sewer and rainwater drainage systems. The robustness of buildings depends on design, execution and quality materials.
On the neighbourhood scale, upgrading includes issues such as place-making to improve the status of projects, through new facade designs, landscaping, and urban design on the pedestrian scale. Social issues must be addressed through services, quality schools, and income generation through focused interventions. Urban infrastructure includes basic sanitation, solid waste handling, and improved mobility. Finally, social and well-being issues need to decrease mobility costs, improve security and services in general and demand investments in community actions and social innovations.

From reflexive interviews with case study users, our background research revealed problems related to internet and Wi-Fi access, the safety of children, and a feeling of insecurity due to a lack of a perimeter fence. Trash disposal and upkeep of public areas were also given priority. Furthermore, users cited legal problems relating to the many transformations of houses encroaching on public land. When ascertaining values in relation to upgrading of housing in general, users favour a perimeter wall for security, covered garages, better indoor acoustic conditions, robust doors and windows, exchange of bathroom and kitchen fixtures, improved electrical installations, quality finishing of walls and floors, the exchange of lamps and increased window dimensions for ventilation and natural light. Finally, larger rooms and better solid waste handling and recycling installations were valued.

Through focus groups, public agents emphasised that to improve the Quilombo development recycling solid waste is important. A playground and a playing field are promised but were put on hold with the allegation that the housing area is legally defined as a condominium, hence the municipal administration bears no obligations to provide further improvements. This attitude also affects improving internet access, public street lighting and fencing of the development, as well as making the existing electronic gates to function. The solution to this last item is considered possible through social services to support the mitigation of conflict between families and create a system to apportion the operation cost of these gates.

A long list of upgrading issues is therefore related to SH in general and to our case study. As a contribution, we focus here on the prioritization of sustainability upgrading actions and classify them according to their potential for implementation in the Brazilian context, to put in perspective relative to mandatory upgrading experienced by European participants in the uVITAL project. For this, the research method concentrated on certification and assessment tools and consultations with design professionals.

3. Method
This research was subdivided into three stages. First, a systematic literature review (SLR) and an analysis of sustainability assessment tools provided the backdrop for the upgrading interventions being currently pursued [15]. Action relevance was assumed as related to their frequency of occurrence in the literature and to their weight asset in the assessment tools. Secondly, the screened SH upgrading actions were prioritized based on implementation costs and technical execution difficulty levels. Consultations with a panel of design professionals rated implementation difficulties concerning labour specialization, time of execution, and intervention invasiveness perspectives. The reference cost surveys used the Brazilian National System for Civil Construction Costs and Indexes Research (SINAPI database) published by CAIXA, the main local SH funder.

3.1. Screening relevant sustainability measures applicable to social housing
Vasconcellos et al. [15] showed that retrofit research publications are concentrated in countries with temperate climates (Köppen-Geiger\(^2\) climatic zone C) [7], most of them in Europe. This explains the predominance of studies on heating-oriented energy efficiency upgrading measures such as improved insulation (55%), and heating efficiency (16%), which were acknowledged as research objectives by 75% of the articles. Thermal comfort aspects as well-motivated research in the remaining 25% of the papers, although not solely regarding heating. Only 13 papers focused on non-European countries, including the one referring to the south of Brazil, the country’s coldest region. The density of European

\(^2\) Equatorial region (A); arid zone (B); warm temperate zone (C); snow zone (D); and polar region (E) [7].
studies relates to the Energy Efficiency Directive (2012/27/EU), which motivated almost one-third of the studies.

In most Brazilian climates, full or partial envelope replacement or heating equipment updates are of little concern, and over-insulating can be even counter-indicated. Also, in Brazil retrofitting windows has mainly to do with shading and sizing for natural ventilation rather than with water tightness or space heating savings. Space heating needs are limited to the country’s south and highland regions. Still, some interest in trending topics at the international forefront [15] is shared in the Brazilian context, like energy-efficient fixtures, mechanical ventilation and cooling; and solar thermal panels or shading elements. However, in cost-restrained applications like SH, commonalities with international research interests seem to lie exactly in the least visited subjects, like water savings, vegetation, acoustics, and layout updates.

Due to the country’s massive solar potential, PV panels have been increasingly used, when budgets allow it, but that is not yet the case of SH. In fact, energy poverty is a major concern for the lowest income group applying for SH (e.g., MCMV Band 1). A recent study on three SH projects in MCMV Band 1 [16] reported average incomes between 82% and 121% of the national minimum wage, respectively 194 and 286 Euros, in today’s terms. Up to 13.6% of the families declared a null monthly income. A reference energy poverty threshold is the average electricity monthly bill of 20 Euros declared by income-equivalent households (based on a data subset of the Individual Credit – CCI - program in the acquisition modality). Families consuming less are considered in high demand for electricity access. For those SH projects, the income share compromised by housing acquisition ranged between 25% and 62.5% [16]. As a reference, a gross debt service ratio considered for mortgage affordability is usually around or little more than 30% of the household income, heating costs included.

Given the specific lack of publications addressing the Brazilian SH context and the dominance of insulation and heating-driven concerns in the SLR output, three housing or building-related assessment systems were examined to provide a broader sense of sustainability aspects applicable to SH. The Housing Quality Indicators (HQI), from the UK, and the Sustainable Building Tool (SBTool), from a multinational consortium, were previously considered sensitive for carrying out SH evaluations in Brazil [1]. The ‘Selo Azul’ building certification was fully developed to address the Brazilian context by CAIXA, which is the main Brazilian SH financing institution.

Some of these assessment tools exceed the investigation focus of this study. They address new buildings of unspecified typologies. Hence, only those categories and topics relevant to SH upgrading were extracted and re-weighted accordingly. The original SBTool’s default weighting set was used in this process. To streamline the items to be further detailed, the Pareto or “80/20” principle was applied to identify the categories responding to over 80% of total weights in each assessment tool. Next, the categories simultaneously bearing the highest weights in all three assessment tools were assumed as consistently relevant in the varied contexts. This simplification was considered necessary to compensate for the lack of specific publications and weighting sets.

To prioritize sustainability measures for SH upgrading found in the previous steps, a public consultation form was created to position the prioritized actions relative to the perceived implementation difficulty (feasibility), in terms of runtime, specialized labour needs, and invasiveness level for implementation. The survey was specifically developed to capture perceptions regarding both single- and multi-family housing typologies. Perceptions were expressed according to a scale of 1 to 5, where the higher the number assigned, the higher the implementation difficulty level. Finally, supply and installation costs were estimated through the SINAPI database, also made available by CAIXA, the Selo Azul sponsor. The interventions were classified in relation to the cost of implementing the solution at the beginning of the construction: (1) Relatively Equal = 0% to 10% of the initial cost; (2) Low = 10% to 20% of the initial cost; (3) Medium = 20% to 50% of the initial cost; (4) High = 50% to 100% of the initial cost; and (5) Extremely High = Above 100% of the initial cost. Items not listed in the SINAPI database were classified according to demolition needs, existing infrastructure, and adjustments.
4. Results and discussion

4.1. Lessons learned

Our background analysis on upgrading actions for SH in Brazil shows that, on the one hand, the literature and our research community do comprise issues of sustainability. The actions collected include all 16 assessment tool items in Figure 2. Both background actions and major concerns found in assessment tools emphasise energy efficiency and indoor thermal comfort as well as landscaping to improve SH.

On the other hand, public agents and users are more concerned with immediate issues and problems. Sustainability is related simply to the changing of lamps, and acoustic comfort is considered more important than thermal comfort. Many users have installed air conditioning and thus energy efficiency should be an important issue. However, these families are on special social interest tariffs and thus energy efficiency is not yet an issue with low consumption in the current climate conditions and its need for air conditioning. Water consumption is also low and public concern for environmental questions such as reduced rainfall due to climate change in our region is not a priority, as more immediate problems exist. The issue of landscaping comes up in user needs and desires, although actions are not clear on how to attain an improved urban neighbourhood landscape through planting and community maintenance.

4.2. Screening sustainability categories from assessment tools

Each rating system reveals its own prioritization structure, which emphasizes different topics according to the local agenda. The critical analysis of the selected assessment tools resulted in 16 general sustainability categories. The corresponding Pareto Charts (Figure 2) show that considering the top 8 categories in each method would cover most sustainability concerns.

| Number | Main Category                                      | HQI  | SBTool | Selo Azul |
|--------|---------------------------------------------------|------|--------|-----------|
| 1      | Leisure and recreation spaces                     | 5,03%| 1,10%  | 5,84%     |
| 2      | Noise sources and acoustic comfort                | 6,66%| 0,56%  | 0,00%     |
| 3      | Visual Identify                                   | 4,10%| 0,00%  | 0,00%     |
| 4      | Solid Waste Collection and Handling               | 5,11%| 8,51%  | 4,38%     |
| 5      | Landscaping                                      | 9,23%| 11,49% | 7,30%     |
| 6      | Security and safety                               | 6,42%| 1,02%  | 0,00%     |
| 7      | Natural and artificial lighting                   | 3,73%| 9,13%  | 0,00%     |
| 8      | Efficient Use of Water                           | 9,88%| 16,47% | 13,14%    |
| 9      | Accessibility                                     | 14,82%| 2,44% | 0,00%     |
| 10     | Circulation and mobility                          | 13,35%| 2,76% | 0,00%     |
| 11     | Sustainable Mobility Solutions                    | 0,93%| 0,74%  | 5,84%     |
| 12     | Energy efficiency and indoor comfort              | 9,05%| 16,06% | 21,17%    |
| 13     | Quality of service in unit                        | 11,69%| 2,28% | 10,58%    |
| 14     | Land regeneration and development                 | 0,00%| 27,19% | 4,38%     |
| 15     | Social development                                | 0,00%| 0,15%  | 16,79%    |
| 16     | Building Systems Maintenance                      | 0,00%| 0,10%  | 10,58%    |

Figure 2. Weighting sets are used by the different assessment tools and respective Pareto charts. The horizontal axes identify the numbered categories tabulated on the left. The categories which simultaneously had the highest weights in all three evaluation systems reviewed (highlighted in grey) were further examined in the subsequent research steps.
The default SBtool weighting set of five categories is weighted heavily, particularly land regeneration (#14), while Selo Azul and HQI distributed relative relevance more smoothly. The British HQI highlights accessibility and mobility aspects, as these still need to be raised to normative standards. Finally, the Brazilian ‘CAIXA Selo Azul’ emphasizes that energy efficiency and social development advances need to be addressed, given the lack of external regulatory or voluntary drivers.

Though the rankings across rating systems varied, three categories were prioritized by all of them: energy efficiency and environmental comfort (#12), efficient water use (#8), and landscaping (#5). Social development (#15, 17%), Quality of service in a unit (#13), and maintenance (#16, 10%) were excluded from the present study but remained on uVITAL’s radar for the emphasis they bear on the Brazilian label (Selo Azul).

4.3. Prioritization of surveyed interventions
Based on the SLR, the consultation form broke down the most relevant categories extracted from the assessment tools into 38 upgrading actions, organized as follows (Table 1):

- Landscape and Landscaping: Permeable Areas; Afforestation; Green Roofs; and Green Walls.
- Efficient Use of Water: Rainwater Use, Greywater Reuse, and Consumption Reduction.
- Energy Efficiency and Environmental Comfort: Energy Saving Devices, Renewable Sources, and Passive Architecture.

| Topic | Subtopic | Solution |
|-------|----------|----------|
| Effic... | Only for garden irrigation | 1 |
| | Secondary use and primary use (direct user contact with water; with a possible aerosols aspiration by the operator) | 2 |
| | Secondary use: garden irrigation; washing floors and sidewalks | 3 |
| | Floor or car wash and garden irrigation | 4 |
| | Composting Toilet | 5 |
| | Double drive valve installation | 6 |
| | Flow regulator registration | 7 |
| | Installation of individual meters | 8 |
| | Installation of double drive water closet flushing | 9 |
| | Installation of faucet aerators in washbasins and sinks | 10 |
| | Installation of timers in showers and faucets In public / common areas | 11 |
| | Installing low flow showers | 12 |

| Topic | Subtopic | Solution |
|-------|----------|----------|
| Energy saving devices | Installation of Individual gas meters | 14 |
| | Installations of efficient light bulbs and fixtures | 15 |
| | Installations of presence sensors and / or timed switches in common areas | 16 |
| | Roof insulation | 17 |
| | High performance glazing | 18 |
| | Installation of external shading elements | 19 |
| | Installation of internal shading elements such as shutters and glazing films | 20 |
| | Openings for cross ventilation | 21 |
| | Use of light colors (lower absorption) | 22 |
| | Deployment of solar water heating with backup system (e.g. electric shower, gas heater) | 23 |
| Renewable sources | Installation of light poles with photovoltaic cells | 24 |
| | Installation of photovoltaic panels In roofs and / or facades | 25 |
| | Installation of (micro) wind turbines | 26 |
| Arborization | Arborization of squares and open spaces | 27 |
| | Arborization in private gardens | 28 |
| | Tree planting on roads | 29 |
| | Extensive green roofs | 30 |
| | Intensive green roofs | 31 |
| | Green facade with vases | 32 |
| | Green facade | 33 |
| | Vertical wall | 34 |
| | Aggregates on geotextile (or similar) blanket | 35 |
| | Drainage blocks (open plot) | 36 |
| | Permeable paving (concrete or asphalt layer) | 37 |
| | Vegetation ground cover | 38 |

Table 1. Upgrading actions identified in the SLR and selected sustainability assessment tools.

Respondents could also propose additional actions. Costs of each upgrading action were estimated by the research team and related to the impressions of 17 professionals regarding their implementation difficulty for both single- and multi-family SH configurations.

When the upgrading actions were contrasted for the two SH typologies (Figure 3), it becomes clear that costs (in orange) and runtime (in grey) show the main discrepancies, whilst invasiveness and specialized labour are in most cases similar. Costs increase by five- (#9, individual water metering) and two-fold (#14, individual gas metering) when shifting from a single- to multi-family application. Though the bank- CAIXA, the largest financier of SH in Brazil, developed its own sustainability certification (Selo Azul), it seems to have failed to boost its wide application to housing projects and to integrate it with other tools developed or sponsored by the bank. For example, only a few of the sustainability
upgrading solutions herein discussed are included in the official costing database (SINAPI) that guides cost surveys for public projects.

Figure 4 shows the optimal quadrants for cost and implementation (runtime | invasiveness | specialized labour need) ease for both single- and multi-family SH. For single-family housing, 17 upgrading actions would combine the lowest costs and implementation difficulty marks for all three descriptors. Multi-family typologies present more implementation challenges, Respondents could also propose additional actions. Costs of each upgrading action were estimated by the research team and related to the impressions of 17 professionals regarding their implementation difficulty for both single- and multi-family SH configurations.

The cost of low-intervention level upgrading was usually not higher than if it were applied in the original construction. The panel of professionals’ output confirmed that simple solutions - such as exchanging faucets, showers, and light bulbs - can be easily applied to both single- and multi-family SH projects, and generally depend only on minor changes, such as changing hydraulic or electrical equipment or improving basic landscaping aspects. But, when highly invasive interventions or the so-called “deep upgrading” are on the table, costs rapidly increase due to the need to substantially change existing systems (e.g., water, hot water or gas sub-metering or rainwater or wastewater supply systems), which makes them often financially and/or technically unfeasible.

**Figure 3.** Implementation difficulty ratio between multi- and single-family (reference) SH application. The numbers refer to the upgrading actions listed in Figure 5.

**Figure 4.** Optimal quadrant (low upgrading actions costs and low implementation difficulty) for single- and multi-family SH. The numbers refer to the upgrading actions listed in Table 1.
Simple features demonstrate to improve resource efficiency to some extent. Still, for most of these, the contribution to reducing indoor discomfort is low, as bad and or cheap design choices prevail in SH models. Long-term discomfort often leads to health problems, productivity loss, and ultimately social unrest that may, in turn, incur high social costs [8].

Some basic design-related aspects, like adding ceilings under roofs, using light colours in roofs and walls, and enlarging window openings, are relatively low cost whilst highly effective in improving liveability and life cycle embodied impacts for the typical SH models. One should remember as well that, if no government-led upgrading programs adequately tackle fundamental indoor discomfort causes, SH dwellers will probably install air conditioning units as soon they can save a little money, a counterproductive measure from the climate action perspective.

5. Conclusions

Identifying upgrading actions is important to help to improve the living conditions and quality of life of the large low-income population of Brazil. Our results show that the multi-family typology presents more implementation challenges than single-family houses. However, we could demonstrate that 12 upgrading actions would combine the lowest costs and implementation challenges and should be prioritized in all cases. These are low-flow hydraulic fixtures, timers or flow control devices in conventional ones, efficient light bulbs, internal shading elements, low-tech green façades, use of light colours, increased greenery, and, upon a little extra money, aerators and double flush WCs and valves.

These minor, low-cost upgrading actions do not cost more than when implementing them from the outcome and can be highly effective in improving liveability and life cycle impacts.

The upgrading actions herein identified for the Brazilian SH context were built upon evidence collected from literature, sustainability assessment tools, and professional expertise. As such, they indeed offer a sound starting point and should be disseminated to reach SH dwellers for self-led upgrading and to instigate government-led upgrading programs. Still, they refer to the researchers’ perspective. User involvement in upgrading processes whether official or user induced is important in this context, as users are yet little concerned with sustainability issues and have more pressing needs. LLs that include sustainability-related upgrades drivers could avoid uninformed, counterproductive measures from the climate action perspective. Understanding priorities from the users’ standpoint is key, and in fact a major centrepiece in LL-based research. To this end, ongoing research has carried out several field actions to stimulate bottom-up priorities, as valued by dwellers, to surface. Interestingly, they complement the technical observations with wishes and expectations of a different nature, and currently drive upgrade proposals being developed.

Acknowledgments

The authors thank the Research Foundation of the State of São Paulo - FAPESP (grant #2020/05311-8 and Trans-Atlantic Platform grant #2019/02240-5) and the National Council for Scientific and Technological development - CNPq (#302080/2017-1 and #306048/2018-3), for their generous support.

References

[1] Adão M C 2018 Sensibilidade e adequação de ferramentas de avaliação de sustentabilidade a habitação de interesse social no Brasil MSc Dissertation (Campinas: Universidade Estadual de Campinas)
[2] Albatici R, Gadotti A, Baldessari C and Chiogna M 2016 A Decision Making Tool for a Comprehensive Evaluation of Building Retrofitting Actions at the Regional Scale Sustainability 8 990
[3] Bridi M E, Soliman-Junior J, Granja A D, Tzortzopoulos P, Gomes V and Kowaltowski D C C K 2022 Living Labs in Social Housing Upgrades: Process, Challenges and Recommendations Sustainability 14 2595
[4] Carpino C, Bruno R and Arcuri N 2020 Social housing refurbishment for the improvement of city sustainability: Identification of targeted interventions based on a disaggregated cost-optimal approach Sustainable Cities and Society 60 102223
Optimisation of a social housing for south of Brazil: From basic performance standard to passive house concept

Energy 167 1278–96

Rethinking social housing: Behavioural patterns and technological innovations

Sustainable Cities and Society 33 102–12

World Map of the Köppen-Geiger climate classification updated

Meteorologische Zeitschrift 15 (3) 259–63

Transformações de Casas Populares: Uma Avaliação ENCAC 95 - III Encontro Nacional e I Encontro Latino-Americano de Conforto no Ambiente Construído.

Proc. (Gramado: ANTAC) 1947–56

A critical analysis of research of a mass-housing programme

Building Research & Information 47 716–33

Critical analysis of housing condition impacts on residents' well-being and social costs

Gestão & Tecnologia de Projetos 16 33–66

Social housing retrofit strategies in England and France: A parametric and behavioural analysis

Energy Research & Social Science 10 62–71

Interpretação como des-ocultamento: contribuições do pensamento hermenêutico e fenomenológico-existencial para análise de dados em pesquisa qualitativa

Pro-Posições 30 1–25

Applying an RRI Filter in Key Learning on Urban Living Labs’ Performance

Sustainability 11 3833

Prioritizing sustainability-oriented upgrade actions for social housing in Brazil

6th International Conference Central Europe towards Sustainable Building CESB22 (Prague: IOP Science) In press

Federal housing program for the requalification of housing developments.

Report elaborated for the National Housing Secretariat of the Ministry of Regional Development. German Cooperation for Sustainable Development Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Product 7. Final version. (Restricted access)