Living labs for user empowerment and value delivery in social housing upgrading processes

Kowaltowski, D.C.C.K.; Gomes da Silva, V.; Van Oel, C.; Granja, A.D.; Muianga, E.A.D.; Kabisch, S.; De Carvalho Moreira, D.; Koolwijk, J.S.J.; Pößneck, J.; More Authors

DOI
10.1016/j.habitatint.2024.103019

Publication date
2024

Document Version
Final published version

Published in
Habitat International

Citation (APA)
Kowaltowski, D. C. C. K., Gomes da Silva, V., Van Oel, C., Granja, A. D., Muianga, E. A. D., Kabisch, S., De Carvalho Moreira, D., Koolwijk, J. S. J., Pößneck, J., & More Authors (2024). Living labs for user empowerment and value delivery in social housing upgrading processes. *Habitat International*, *145*, Article 103019. https://doi.org/10.1016/j.habitatint.2024.103019

Habitat International 145 (2024) 103019

Contents lists available at ScienceDirect

Habitat International

journal homepage: www.elsevier.com/locate/habitatint

Living labs for user empowerment and value delivery in social housing upgrading processes

D.C.C.K. Kowaltowski [a,*], V. Gomes da Silva [a], C. Van Oel [c], A.D. Granja [a], E.A.D. Muianga [a], S. Kabisch [b], D. De Carvalho Moreira [a], J.S.J. Koolwijk [c], J. Pößneck [b], P.T. Tzortzopoulos [d], J. Soliman Jr [d], M.E. Bridi [a], A. Freeke [c]

[a] University of Campinas (UNICAMP) Department of Architecture and Construction (DAC), Faculty of Civil Engineering, Architecture and Urban Design (FECFAU), Av. Albert Einstein 951, Campinas, SP, CEP 13083-852, Brazil
[b] UFZ Helmholtz Centre for Environmental Research, Department of Urban and Environmental Sociology (DUES), Leipzig, Germany
[c] Delft University of Technology (TUD), Faculty of Architecture and the Built Environment (ABE), and New Media Centre (NMC), Delft, the Netherlands
[d] University of Huddersfield (HUDD), Innovative Design Lab (IDL), School of Art, Design and Architecture (SADA), Huddersfield, UK

ARTICLE INFO

Keywords:
User-centred design. participatory design. case studies. living labs. social housing upgrading

ABSTRACT

Upgrading existing social housing (SH) requires user-centred participatory processes to promote values. Comparative case studies in Brazil, Germany, the Netherlands, and the UK are presented. Living Labs (LLs) were conducted for the delivery of user values and to promote an informed decision-making process. Tools and LL activities were tested to engage stakeholders in the upgrading process, support the co-creation of solutions and address social and societal challenges. The main research aims were to facilitate SH upgrading processes focusing on the delivery of value for users, achieving end-user empowerment, as well as assessing participatory decision-making through LLs. Research goals were achieved in each case study setting. The evaluation of specific cases informed a conceptual framework and guidelines to facilitate upgrading through LLs in varied SH landscapes.

1. Introduction

Social Housing (SH) upgrading is discussed in the literature under different terms, such as refurbishment, retrofit, renovation, and maintenance. The main goal of upgrading programmes, beyond maintenance, is to improve populations' living conditions and to increase the environmental sustainability of housing estates.

The existing housing stock worldwide needs attention to bring buildings and surroundings to expected standards (Kæseler et al., 2019; Kowaltowski et al., 2019; Scuderi, 2019). Successful upgrading may bring favourable social, health, and financial outcomes for populations and positive environmental impacts. Interventions require research and social innovation to improve residents' lives and increase the sustainability of the built environment (Mulgan et al., 2007, p. 52).

Upgrading is aligned with several of the UN'sustainable Development Goals - SDGs[1] (Coyne et al., 2018; Vilches et al., 2017). European countries took the lead with SDG13 (climate action), as the European Climate Law establishes a regulatory framework for national governments towards climate neutrality, to ensure that the existing housing stock meets increasing energy performance requirements (Regulation, 2021; Directive, 2023). Financial incentives and loans are made available to housing owners and housing associations.

Contrastingly, in most developing countries, bringing SH quality up to recommended standards of socially, environmentally, and architecturally appropriate designs that are accessible, adaptable, safe, secure, affordable, durable and resource-efficient has yet to come into effect (ACE, 2022, p. 14). In Brazil, for example, the government recently disclosed specific funding for SH upgrading,[2] however as yet without a framework for setting up effective participatory processes that could ensure that user values are prioritised in upgrading interventions. After

* Corresponding author.
E-mail addresses: sis-au@unicamp.br (D.C.C.K. Kowaltowski), vangomes@unicamp.br (V. Gomes da Silva), c.j.vanoel@tudelft.nl (C. Van Oel), adgranja@unicamp.br (A.D. Granja), elisa.atalia@gmail.com (E.A.D. Muianga), sigrun.kabisch@ufz.de (S. Kabisch), damore@unicamp.br (D. De Carvalho Moreira), j.s.j.koolwijk@tudelft.nl (J.S.J. Koolwijk), janine.poessneck@ufz.de (J. Pößneck), p.tzortzopoulos@hud.ac.uk (P.T. Tzortzopoulos), Joao.SolimanJunior@hud.ac.uk (J. Soliman Jr), marcelle.bridi@gmail.com (M.E. Bridi), a.freeke@tudelft.nl (A. Freeke).

[1] https://sdgs.un.org/goals.
[2] https://www12.senado.leg.br/noticias/materias/2023/06/01/comissao-mista-aprova-mp-que-retoma-minha-casa-minha-vida.

https://doi.org/10.1016/j.habitatint.2024.103019
Received 12 July 2023; Received in revised form 18 January 2024; Accepted 22 January 2024
Available online 2 February 2024

moving from precarious living conditions to SH, end-users typically express satisfaction with their new living conditions, which perpetuates the lack of official incentives to upgrade (Serapião, 2016). In such a context, families soon embark on self-induced - often substantial - housing transformations, mainly to increase functional space (Muianga et al., 2022; Tipple, 2000). Housing extensions usually reduce natural light and ventilation and sacrifice gardens (Soliman-Junior, Awwal, Tzortzopoulos, Ayo-Adejuyigbe, & Kagioglou, 2022; Umeh et al., 2023). Informed upgrading is therefore needed.

This paper presents four cases of living labs for SH upgrading developed within the transatlantic research Project.[3] A multidisciplinary international partnership analysed if and how the use of Living Labs (LLs) can smooth SH upgrade delivery whilst ensuring that user values are adequately accounted for. Three cases were conducted in Europe - Germany (DE), the Netherlands (NL), and the United Kingdom (UK) – and the fourth case was in Brazil (BR). Each country presents its own climate, culture, administrative system, architectural design approach, and construction technologies. More strikingly, the European cases are based on mandatory energy efficiency-driven upgrading, whereas in Brazil the homeowners carry out individual upgrades.

LLs are participatory planning processes aiming at informed decision-making, mutual learning, and behaviour change among stakeholders (Cognetti, 2023; Hossu et al., 2022). Although widely applied in urban participatory planning and, recently, to large-scale SH regenerations (Cognetti, 2023), studies on the concept of LLs to upgrade SH with detailed descriptions of context, tools, and process strategies are scarce. Hence, our research aims to contribute insights for LL conceptualising and setting up LLs that more effectively engage users in participatory SH upgrading processes with enhanced social cohesion and lasting effects (Fig. 1).

The study was driven by the following research questions.

- How do contextual conditions affect the processes to upgrade SH with the application of LLs?
- Which processes and tools led to efficient upgrading processes through informed decision-making?
- To what extent did user empowerment enable meeting user needs and value delivery?
- What sort of guidance could be offered to future LL studies addressing the critical issues underpinning SH upgrades?

A multiple exploratory case study design was chosen. The research answers we sought then shaped our main research deliverables: a collection of specific to generally customisable guidelines and an orientation framework for setting up LLs for user-centred upgrading approaches in the context of economically underprivileged estates that lack social stability and action continuity.

2. Underlying concepts

Our investigation covered the topics of value delivery in SH upgrading, LLs and participatory design as well as concepts for a framework development for user-centred SH upgrading processes.

2.1. SH upgrading and user value

Many SH areas have environmental and social conditions, with crime and unemployment rates impacting social costs, that can exert political pressure to promote change in existing SH developments. Social costs are primarily incurred through health problems caused by dysfunctional and insalubrious living conditions (Kapp, 1970; Hards, 2013; Muianga et al., 2021). Fuel poverty, social exclusion, family conflict, and urban violence may also create social costs (Watson et al., 2016).

Cultural, social, and technological evolution shorten the service life of SH. However, replacing the old SH stock often has adverse economic and environmental effects. Upgrading the existing stock can be more economical than demolition, with added environmental impacts through carbon reductions (Alba-Rodríguez et al., 2017; Power, 2008). Improving existing housing may also reduce housing deficits (Buckley et al., 2016; Kowaltowski et al., 2019).

Upgrading programmes should ensure that homes are in a good state of repair, safe and secure, comfortable, adequately heated, well insulated, energy-efficient, correctly managed, and located in attractive and safe environments (Poortinga et al., 2017), whilst avoiding rent increases and, ultimately, gentrification (Kæseler et al., 2019; Stenberg, 2018).

Most programmes address construction maintenance demands (Crawford et al., 2014), better comfort conditions and improved project sustainability performance (Oorschot et al., 2018). Resilience to social, political, and emergencies such as pandemics, the influx of conflict refugees and - most strikingly - climate change are further concerns (Xu et al., 2021; Xu & Juan, 2021; ACE, 2022, p. 14).

Climate change is an urgent global issue, demanding increasingly responsible actions to value users' vulnerability to its effects and attention to carbon and energy efficiency. Implementation of SH upgrading programs, however, depends on legislation, political will, and favourable economic conditions (Kamarulzaman et al., 2019). In Europe, the Energy Performance of Buildings Directive mandates the reduction of carbon emissions (Vilches et al., 2017; Coyne et al., 2018; Directive (EU), 2023/1791), and windows and installations are replaced and envelope insulation is improved through mandatory refurbishment (Oorschot et al., 2018).

Contrastingly, in the many countries that lack an energy efficiency drive, transformations of homes by users as owners are more concerned with functional issues (Gnecco et al., 2022). In Brazil, for example, SH owners receive social interest electricity rates, discouraging energy efficiency investments. The incentive to upgrade is mostly individual, crafted by the family's needs, and caused by housing projects with insufficient environmental and construction quality (Kowaltowski et al., 2006; Kowaltowski et al., 2019). In such contexts, the extent and pace of the transformations executed depend primarily on the resources a family can muster to finance renovations (Vilches et al., 2017).

Value is the ratio of a perceived benefit over sacrifices made to acquire a specific product or service (Monroe, 1990). Benefits of SH include well-being and comfort for inhabitants and user retention for SH authorities. Increasing the sustainability of projects is an important benefit for society as a whole. Sacrifices relate to social, psychological, and financial costs (Kowaltowski & Granja, 2011).

As part of the ethical principle of human-centred design, SH upgrading should attain the user values of practicality, ingenuity, appropriateness, and empathy (Kowaltowski, 1980; Kowaltowski & Granja, 2011; Heylighen & Dong, 2019; Cross, 2007). These values translate into increased comfort for users and should ensure a secure and pleasant place to live. Values change over time, and lifestyle changes have an impact on practicality and appropriateness (Thomson et al., 2013; Soliman-Junior et al., 2022).

SH upgrading also aims to deliver values related to psychological feelings of belonging, place attachment, and increased satisfaction levels for individuals and communities. Tenants feel valued after the upgrading of their homes and neighbourhoods was accomplished and will attest that their way of life improved with increased feelings of security (Chileshe et al., 2013). A novelty effect can also improve social behaviour and social cohesion with an increase in the effective participation of users in caring for their home environment (Yang et al., 2009).

Whether mandated by legislation or instigated by users, the many stakeholders involved in upgrading should ideally work together to assess, analyse, and deliver user values. These will be different for tenants or owners, and in upgrading projects, financing by public

[3] "User-Valued Innovations for Social Housing Upgrading through Trans-Atlantic Living Labs".

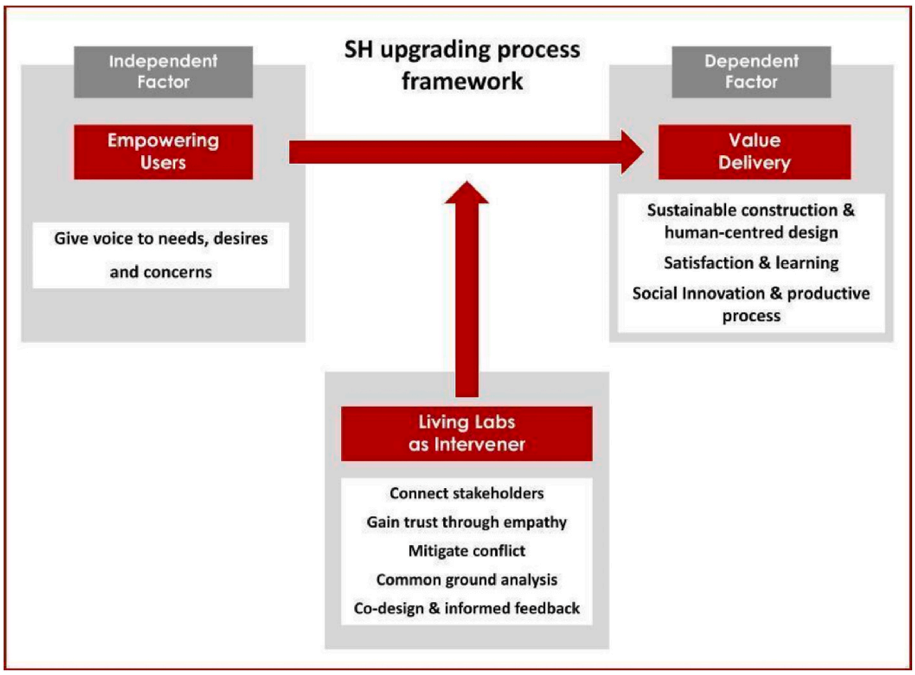

Fig. 1. Study framework for social innovation in decision-making processes of SH upgrading processes (Source: The authors).

institutions or by users themselves will impact value perception. Stakeholders, like housing associations and contractors, may see end-users as a burden, refraining from value discussions to prevent raising demands that impact costs (Kæseler et al., 2019). As hidden agendas may exist, collaborative practices should promote negotiations with a shared focus, involving all stakeholders of an upgrading project. Collaboration is built on trust, equality of voice and reflection by all parties. Mutual respect is essential. Participatory methods and actions such as those promoted by LLs can improve stakeholder interaction, mitigate conflict, and deliver value for all parties.

2.2. *Living labs (LLs) and participatory design*

LLs are considered a social innovation in decision-making processes that mobilise human and environmental values (Lapointe et al., 2021). Dell'Era and Landoni (2014) consider LLs a development of participatory methodologies, embracing the pluralism of values. Participation is a concept applied in various fields with diverse meanings and methods used to achieve productive decision-making (Luck, 2018; Schuler & Namioka, 1993). Participatory or collaborative design involves not only designers but should also include end-users in design processes. The goal is to respond to people's needs and desires in the search for solutions to design problems. Co-design, through design charrettes, may be part of such processes, with users participating in idea generation as well as decision-making.

The origin of participatory design links to the development of design methods (Broadbent & Ward, 1969). In the 1960s a rational approach was advocated for problem solving (Cross, 1993). Ten years later, criticisms recommended argumentative participatory processes or soft system methods. Thus, designers should work as partners with clients, users and the community (Broadbent, 2003; Cross, 1993). End-users are valued and design assumes an important sociocultural role (Banathy, 1996; Buchanan, 1992).

Participatory design processes involve individual, social and spatial factors. Technical know-how and understanding of design problems and solutions will however often be at different levels among participants, and personal and community priorities may conflict. Stenberg (2018) presents arguments both in favour of and against participation in upgrading processes. The various stakeholders involved have different goals and viewpoints and thus the sharing of power might be difficult. In the case of users as tenants, residents are usually the weak stakeholders in upgrading processes. Tokenism may permeate a participatory process, with "smokescreens" to hide specific stakeholders' interests (Gustavsson & Elander, 2016). In SH upgrading, building trust with tenants is fundamental so that users gain knowledge and a sense of ownership of the newly introduced improvements. Positive behaviour changes are expected from successful participatory upgrading processes.

LLs advocate for engaging people in different ways within a real-life context for joint decision-making, mutual collaborative learning, co-creation, knowledge building, and user empowerment (Hossu et al., 2022; Luck, 2018; Smith & Iversen, 2018; van Geenhuizen, 2018, 2019), which are considered essential to sustain solutions (Leminen et al., 2017; Kæseler et al., 2019; Bridi et al., 2022; Fasshauer, 2022).

Diverse research methods, tools, and approaches are applied, and LLs have at least three phases of: analysis, innovation and co-creation and finally evaluation or feedback (Buhl et al., 2017; Leminen et al., 2017; Bridi et al., 2022). Communication barriers between stakeholders can be addressed through engagement tools and boundary-spanning facilitators (van Geenhuizen, 2018). Collaborative approaches and face-to-face dialogues are recommended to reach informed decisions (Bridi et al., 2022).

In LLs for SH upgrading processes, not only the end-users and the owners - which may be housing authorities, housing associations or companies, landlords, or occupant-owners – but also the private sector (design professionals and construction companies) and academics are relevant stakeholders to be involved.

In such settings, a socially safe environment that supports harmonious and open dialogues with all parties to discuss problems and their solutions not only enhances the quality of the final product but also empowers end-users to have a more significant impact on the outcome (Koolwijk, 2022), as they feel heard and valued. Furthermore, professional facilitators and assisting technologies should support end-users to effectively express what holds value for them in the project, overcoming communication barriers (Gsenger et al., 2020, pp. 1–10).

Successful LLs outcomes are challenged by non-collaborative attitudes (Bridi et al., 2022), as well as by temporality and failures in user recruitment, governance, efficiency, continuity, scalability, and unpredictable issues (Hossain et al., 2019).

2.3. Framework development for user-centred SH upgrading processes

To mitigate issues associated with LLs, van der Have and Rubalcaba (2016) highlight the need to achieve social innovation in participatory processes, emphasising citizen engagement. Community psychology and conflict assessment, as well as social and societal challenges, should be considered, as both increased social cohesion and an improved built environment are envisioned.

Kæseler et al. (2019) identified tokenism of user involvement in refurbishment case studies, recommending a three-phased setup for user-driven innovations. Also, all user activities should run concurrently with the upgrading process, and actions and approaches should be specifically crafted.

Fasshauer (2022) indicates a participatory user-centred argumentative design method that facilitates engagement, delivers values and meets stakeholder expectations. Consequently, social, economic, and societal values should be able to be achievable through co-creation.

Smith and Iversen (2018) emphasise scoping, developing, and scaling social change. Accordingly, participation is achieved through scoping processes that have learning objectives. Also, according to the authors, LLs need to constantly (re)invent and (re)position themselves through flexible forms of engagement with diverse stakeholders to empower them to become co-agents in all phases of participation. To achieve sustainable social change, Smith and Iversen (2018) indicate scaling projects beyond individual actors.

Van Greenhuizen (2018 & 2019) show that increased learning and facilitation of co-design can lead to long-term community involvement. Also, the author points out that LLs involve stakeholders with different objectives, experiences, and levels of education and know-how. Boundary spanning, through specially trained facilitators and tools, thus can underpin ethical participation processes and efficient knowledge transfer (van Geenhuizen, 2018).

3. Research method

Once our literature review established the theoretical background and underlying concepts involved in applying LLs to SH upgrades, a multiple exploratory case study design was chosen to provide evidence and answers to our research questions. The investigation proceeded with selecting case studies, developing the settings for LLs in each context and framing the analysis of their outcomes. As inductive observational experiments, case studies can capture essential information to create theoretical constructs (Eisenhardt & Graebner, 2007).

3.1. Selection of case studies

A purposeful selection of four exploratory case studies - existing SH projects in need of upgrading in Brazil, Germany, the Netherlands, and the UK - was carried out (Patton, 2014), to support the development of a guiding procedure that may facilitate SH upgrading processes through the use of LLs.

The primary selection criterion was systemic poverty, acknowledging its different levels across the four countries. Europe, broadly speaking, has two categories of social rented housing: either held by municipal entities or managed by non-profit organisations (housing associations). Germany, the Netherlands and the UK maintain a mix of ownership types. Differences in access to SH across cases exist and upgrading is managed through different mechanisms in each country (Castellazzi et al., 2019). Also, each project has its own conditions and follows local practices. The Brazilian SH case needed upgrading, whilst the European cases were undergoing refurbishment.

In Brazil, SH is heavily subsidised by federal and state funds. Low-income families with a monthly income of circa €498,00 (for 1 BRL = €0,1,890,038) are selected by the federal bank. Users are property owners, who pay small instalments over long periods. Housing companies provide maintenance for five years after occupation. Some projects deliver houses without complete internal finishing, inducing owners to begin informal transformations soon after occupation.

In Germany, SH is subsidised and characterised by a rent and access regulation and specific eligibility criteria (Droste & Knorr-Siedow, 2014; Housing Europe, 2023). When it comes to upgrading, there is a difference between maintenance and measures that increase the utility value of a residential building. There are two main issues for upgrading in Germany: energy-efficient refurbishment and age-appropriate conversion. Both usually lead to rent increases, which are a particular burden on low-income households. To obtain a financial grant or loan, housing companies can apply for funding programmes, such as those offered by the German state-owned development bank.

Dutch SH is primarily provided by housing associations, non-profit organisations, responsible for managing and providing affordable rental housing to the population. Maximum annual income limits for SH eligibility are €40,024 (single-person household) and €45,034 for a multi-person household. Rent remains unchanged even if the household becomes no longer eligible for housing allowances. The tenancy is typically for an indefinite period. A guarantee system serves as a financial safety net for housing associations to secure loans at low costs, including funds to comply with a voluntary National Performance Agreement to the European Energy Efficiency Building Directive (Castellazzi et al., 2019).

In the UK, social housing is provided and managed by local authorities and housing associations. Rents can increase as it is linked to household income. Refurbishment is regulated through a standard for energy retrofit of domestic buildings - PAS 2035; BSI, 2020), which became mandatory in 2021. Technical (e.g., heating demand, thermal performance, airtightness) and non-technical requirements (e.g., comfort, occupancy) are included. The standard defines the responsibilities of advisors, assessors, coordinators, designers and evaluators.

Our selection sought to differentiate case studies regarding building age, type, project size, user profiles and into tenant (Europe) and owner-occupied (Brazil) cases. Both the Brazilian and the UK cases have younger families, while in Germany and the Netherlands, tenants are primarily single elderly residents. A specific feature of the UK case was that it was part of a pilot refurbishment study encompassing eight houses within a large SH development built some 80 years ago. In all four countries housing associations or local authorities suggested cases according to the described criteria.

3.2. LLs settings and development

All LLs comprised the 'understanding - co-creation – evaluation' cycle. LL procedures were developed by each academic team as shared and aligned research approaches.

LL events and onsite visits took place, using engagement tools like value and focus cards, virtual reality (VR), videos, building information modeling (BIM), and physical 3D maps and models. Social interaction methods were developed and applied, including questionnaire surveys, reflexive interviews (Szymanski et al., 2019), guideline-based expert interviews, focus groups, co-design, design charrettes, and workshops.

LL activities and tools were tailored for local particularities, participant knowledge, the type of equipment used, and available funds. In Brazil, the LL was supported by value cards and 3D maps and models. In Germany, data was collected through extensive expert interviews. A 3D visualisation application with design scenarios for green areas was developed. VR was used in the Netherlands, and BIM models, value cards and VR were applied in the UK.

3.3. Analysis of case studies

The analysis sought theoretical replication in the data collected from diverse scenarios (Yin, 2013). The investigation was driven by stakeholder involvement in LL phases, collaborative decision-making, end-user empowerment, learning, common ground discussions, and

co-design outcomes. The analysis also explored the challenges of conducting LLs and critical LL procedures.

The procedures adopted underwent comprehensive analysis using qualitative interviews to identify potential actions for LL. The insights obtained through observation were generalised, resulting in recommended strategies for more effectively conducting upgrading processes. These recommendation guidelines were grouped under six topics: (1) Managing LLs, (2) Mitigating conflict, gaining trust and achieving end-user empowerment with social cohesion, (3) Informing decision-making and collective learning, (4) Applying context-driven activities and tools, (5) Defining scope and (6) Triggering essential questions. The case study origin of each guideline is identified and country-specific applicability is indicated. Data is visualised through a Sankey Diagram.

4. Description of case studies

Fig. 2 shows the SH projects in each country, and Fig. 3 details them further. Case studies aimed to empower users, improve social cohesion and mitigate existing - or emerging - conflicts to smooth out the upgrading process.

Given the emphasis on user-empowerment, SH tenants or owners were the essential stakeholders in the LLs in all four cases. Representatives of housing associations and municipal authorities participated in specific LL events and were involved in opening communication channels and access to users.

In the German case, a facilitator with long experience with the project participated in LL activities as well as construction company representatives and workers. In Brazil, the housing company and the municipal housing secretary participated in the co-design charrette. In the Dutch case, the housing association and the contractor were present in the VR presentations; decision-making was limited to a set of choices on bathrooms and kitchen finishings, and gardens were discussed. In the UK, the local authority provided access to users after a pilot study of refurbishment was completed, and both users and local authority representatives took part in LLs.

Figs. 2 and 3 present the differences across cases relative to age, size, building type and ownership status. Income levels also must be considered, with Brazil having the lowest economic group. Furthermore, the Brazilian case did not undergo an official refurbishment programme.

Upgrading is not totally funded. In Brazil, energy efficiency refurbishment is not mandatory, nor are buildings or grounds upgrading; only basic maintenance is covered in the first five years after handover. In Europe, tenants pay rent, which is, in part, used for refurbishment. Policies and mandatory standards are slightly different in each of the European cases according to specific country regulations (Castellazzi et al., 2019).

The Brazilian case - named Quilombo - is located in Campinas, in the State of São Paulo and consists of a small SH development with around one hundred row houses along two short streets. The German case study comprises four nine-story apartment buildings in a large social housing estate, at the western fringe of the city of Leipzig. Located in Veendam, the case in the Netherlands relates to a project with 60 apartments in two-story buildings. Earthquakes triggered by natural gas extraction have caused substantial damage to buildings in this region, with economic and social ramifications. The case study in the UK is a small renovation project of 8 houses in West Yorkshire, as a pilot study in a large SH neighbourhood developed by the local council.

5. Findings and discussion

Our findings directly stem from the analysis of the four cases, providing research products that offer guidance for future studies, which can benefit from the approach used and lessons learned.

5.1. Insights gained from LLs settings

Fig. 5 shows the timeline within the three phases of the four LLs, with a concentration of activities in the first LL phase. Examples of events are shown in Fig. 4, and Fig. 6 presents the tools applied.

The research was conducted during the COVID-19 pandemic; hence first contact activities were delayed. Inter-person contact was restricted during the lockdown phase, and interviews were conducted online. In-person events using visualisation tools occurred once risks were eased.

Signs of conflict at the initial stage of the upgrading processes were observed. In Europe, conflicts were between tenants and housing associations as well as construction workers during the actual renovations. In Brazil, mistrust existed between families. In Brazil, conflicts were mainly over the costs of shared interventions in public areas. Also, communication with the housing company and the municipal housing secretary and social services was strained, as users expected improvements at no cost in public areas.

Conflicts were reduced as users gained a voice to express desires and anxieties. A distinct sense of user empowerment and knowledge sharing on upgrading options and proceedings occurred. In the case of the UK, tenants expressed dissatisfaction at the outset of the LL. There was restricted user participation in early upgrading decision-making, and the LL activities occurred after the completion of refurbishments on site. However, the LL events achieved user engagement to improve common areas, redesign fences and solve solid waste area management.

The first end-user contact events were distinct in the four cases. Brazil had a reflexive interview and distributed a self-analysis (toolkit) to gain trust, encourage active involvement, and identify priorities. Germany applied a large survey to assess satisfaction rates and user priorities (Kabisch, Poessneck, Soeding, & Schlink, 2022). The UK conducted interviews to introduce the research team and LL activities.

Direct and early communication with users was prioritised in Brazil, Germany, and the Netherlands, using both simple as well sophisticated visualisation tools. In Brazil, different activities were introduced as the LL was researcher-induced, without the participation of the local housing company or the private sector. To mitigate conflict, and find common ground on issues, first-user contacts are important.

Community garden revitalisation was identified as an attractive co-design issue, while private spaces need to be discussed on an individual basis to preserve the privacy of users. The need for housing associations to commit to the execution of co-design solutions and to increase attention to private spaces and surroundings became clear. For Brazil, the need to create a SH upgrading funding programme.

Became evident and our findings should contribute to the formulation of the recently revived SH programme "*Minha Casa Minha Vida*", for upgrading processes of the large existing SH stock.[4]

Events and tools needed thorough preparation and management of expectations. Repeated contacts and frequent feedback increased engagement. After engagement, especially in European cases, users gained a sense of empowerment to voice their needs, desires, and concerns. Improved social cohesion was considered essential to enhance public areas. In the Netherlands and the UK, users gained a greater understanding of the refurbishment process through realistic visualisations of upgrading procedures and options. An increased perception of the built environment became apparent during discussions and co-design. This was an important insight in the Brazilian case as well, as users act individually to improve their homes. In the Netherlands, this experience convinced the housing association and the contractor to house residents in temporary units on the same site's external area. The housing associations realised the value of academic teams as facilitators to mitigate conflict or manage expectations. Communicating directly with users and informing workers to respect user privacy was considered

[4] (https://www12.senado.leg.br/noticias/materias/2023/07/14/sancionada-lei-que-retoma-o-minha-casa-minha-vida).

Fig. 2. Views of the transatlantic SH case studies (Source: The authors).

helpful in Germany.

Advantages and challenges for the application of LLs to SH upgrading were identified. Thus, the advantages are that LLs enable a smooth upgrading construction process. Users are valued and engaged. LLs help keep participation alive and maintain trust. Users are given individual voices through empowerment and stimulated with questions on the upgrading process. Assessment of upgrading priorities and technical information dissemination support co-design for solutions and informed decision-making. Mitigating conflict can be achieved and learning gained by all stakeholders. Also, trust between academics and users can be strengthened.

Difficulties concern the preparation time and technicalities required to guarantee user engagement. To trigger crucial questions about climate change and new ways of living is challenging. Also, topics not part of mandatory upgrading, such as floorplan changes, should be avoided as they may create false expectations. Establishing continuous relationships with the main stakeholders, like government agencies and construction companies, is also difficult.

When it comes to the tools (Fig. 6) used in LL events, specific insights were gained. VR is shown to be an attractive tool that facilitates the visualisation of upgrading processes, design choices, and co-design. During a VR session, a technical guide should be present to assist participants in navigating models. Technicalities need prior testing concerning the levels of skills and spatial experience of participants to gauge the level of immersion. As a further result, participants showed difficulties using a cave automatic virtual environment (CAVE), thus giving preference to the visualisation of 3D models with VR glasses.

BIM can enable interactions, facilitate the visualisation of options, and allow the evaluation of the feasibility of options. BIM, as a construction workflow software, however, focuses excessively on technical issues. The charrette co-design was a more successful engagement activity as semi-public areas and gardens can be more realistically visualised with expected results.

Value cards were shown to be a simple interactive tool to allow the assessment of upgrading priorities and options. Adaptations were necessary for specific contexts. Focus cards facilitated group debate management, allowing the visualisation of discussion topics, and stimulating ideas in co-design. The 3D visualisation application in the form of a video, although a simple and well-known visual means to show scenarios, showed reduced interactions and co-design possibilities.

5.2. *Research contributions*

Although our investigation is limited to four case studies, a framework could be generalised as a guiding procedure to conduct LLs for SH upgrading (Fig. 7). This framework and the guiding recommendations in Table 1 summarise the results of our transatlantic research collaboration.

The framework is conceptually based on Fasshauer (2022), Kæseler et al. (2019), Smith and Iversen (2018), van der Have and Rubalcaba (2016) and van Geenhuizen (2018 and 2019), and infused with the case studies outcomes. Contextual drivers and specific local conditions and goals broadly frame 3-phased LL settings, which are finely tuned based on tools and activities recommended for boundary spanning and gaining common ground and trust.

Thus, drivers of upgrading processes include concerns that can increase or mitigate social costs. Local conditions refer to social cohesion and conflict assessment, expectations of all stakeholders and physical attributes. Mitigating conflicts, costs and climate change, facilitating decision-making, delivering user values, and increasing learning are all essential concerns to address when seeking to improve overall housing conditions.

The analysis of our results introduces critical as well as practical insights to conduct SH upgrading processes through LLs without tokenism. Lessons learned revealed 72 guidelines, which were categorised according to the six main issues: (1) Managing LLs, (2) Mitigating conflict, gaining trust and achieving end-user empowerment with social cohesion, (3) Informing decision-making and collective learning,

Social housing estate	Brazil: Quilombo, Campinas, SP	Germany: Grünau Leipzig	The Netherlands: Veendam, Groningen	UK: West Yorkshire
Built by: Managed by:	*Programa de Aceleração do Crescimento*, COHAB (municipal housing company) of Campinas	Municipal housing company	Acantus association	Local Authority
Age of projects, dates	2009 built 2013 occupied 2022 ownership transferal	Between 1982 and 1984	1969	Between 1930 and 1949
Construction type characteristics	Conventional concrete block masonry	Industrial panel construction	Concrete structure, brick façade, wooden window frames with widespread building damage	Cavity wall (filled), roof pitched, suspended floor, window fully double glazed, central heating (boiler and radiators, gas mains)
Units/habitants	96 single-family, semi-detached houses	8 housing complexes 45,000 inhabitants	3 building blocks, low-rise, 60 homes (2-bedroom apartments). Plot area: 6,959 m2	156 single-family, two-storey terraced houses
Case study	96 semi-detached houses	Four nine-story buildings (each with around 100 apartments)	Low rise walkup apartment blocks	8 row houses as pilot project
Users' characteristics	Varied sized families, many extended families	Primarily the elderly, living alone	Primarily immigrants, av. age: 44	Families
Area	45m2/Residential Unit	1-room apartments about 30 m2, 2-room-apartment about 40-62 m2	Ground floor units 63m2, First-floor units with attic 90m2	60m2 / Residential Unit
Income level	€498,00 month	Middle- and low-income level renters	Tenants; low income (€27.300/year); 60%	Low-income level renters £980/month (range £437 - £1200) / household
Unit owners	Users	Municipal housing company, mainly rental housing stock	Average rent €476.66 per month	Average rent £320 monthly
Upgrading process lead- agents	Users	Municipal housing company	Housing association	Council authorities
Upgrading focus	Support individual and community demands, no official upgrading underway	Energy efficiency, accessibility, general infrastructure renewal underway	Energy efficiency (free of natural gas by 2050), safety and health (asbestos, concrete rot risk), aesthetic components, kitchen and bathroom renovation, maintenance	Net zero and energy efficiency goals, façade and fence improvements

Fig. 3. Descriptive details of the four cases (Source: The authors).

(4) Applying context-driven activities and tools, (5) Defining scope and (6) Triggering essential questions. Major recommendations are highlighted in Table 1.

The table presents the guideline categories and to the right the LLs where a guideline originated. In the right most column prevalent context applicability is indicated. Analysis of the origins and the essential applicability to specific or to all countries shows that, for example, insights from the Dutch case study contributed to numerous recommendations applicable across cases. We can relate this result to two factors. First, this LL process was inclusive, encompassing all stakeholders. Second, commitments by project managing stakeholders and the presence of the academic team on the scene, applying attractive tools, increased user engagement.

In Europe, the process is organised and executed primarily to introduce energy efficiency measures. In Brazil, ingrained conditions still hamper attempts to create official upgrading programmes and reverse social injustices. Despite the specific social, economic and policy contexts (Fig. 3) and own SH landscapes that the case studies operate in, Table 1 indicates that our research consortium produced a rich array of recommended guidelines, applicable across cases.

General insights gained contribute to knowledge regarding participatory processes, especially for SH upgrading. Both users and housing associations considered LLs positive participatory additions to SH upgrading processes, which proved to be an efficient way to bridge social sciences and design issues. More strikingly, regardless of the different cultures, policies, and even values found in each country, insights gained apply to a wide context range, as guidelines in Table 1 primarily treat universal participatory planning issues.

The Brazilian experiment, despite being the outlying case without an actual upgrading process underway, revealed several guidelines that apply to all cases. These relate to awareness of differences between tenants and owners, gaining trust and conducting reflexive interviews for rapport at first user engagement meetings. Also, lessons were learned about avoiding false expectations and on thermal overheating for individual houses. Germany demonstrated the importance of facilitators and actively involving construction workers in LLs. The Dutch case was an important source for insights on first contacts, tool development and achieving a smooth refurbishment process through VR presentations to users, housing associations and contractors. The UK case demonstrated that small pilot refurbishments in a large social housing estate can cause conflicts. To avoid negative user sentiments, with feelings of being left out, pilot studies in large housing estates must be carefully managed with adequate communication with all residents.

Important recommendations relate to the upgrading processes as such. They entail planning, design, contracting, procurement and funds. Well-thought-out procedures should aim for tangible positive social change results and built environment improvements that deliver value to all (users, housing associations, contractors and society as a whole).

Timing in LLs is crucial to gaining trust, breaking the ice, and discovering common ground issues. Visualisation of the existing house and design solution ideas increase engagement, understanding, and satisfaction. Both analogue and digital tools are applicable, but these require facilitators and adjustments to deal with unforeseen situations. A flexible approach is recommended.

Activities with a ludic aspect and with children can increase community participation. A design charrette involving users in the co-design of public areas can promote informed decision-making. Drawings allow the visualisation of potential upgrading solutions that can be directly

Fig. 4. Scenes of activities in Living Lab events (Source: The authors).

discussed through a user-friendly design language. Awareness of user-group characteristics should indicate the choice of tools and their configuration, especially with elderly or immigrant residents. Step-by-step methods are recommended with focused reflections.

Literature indicates that the presence of all multi-agent stakeholders is essential in LLs (van Geenhuizen, 2018). However, our results show that, especially once stakeholders are committed to the upgrading process, decision-making does not necessarily have to occur simultaneously with all stakeholders. Also, conducting SH upgrading processes through LLs led by an independent multidisciplinary academic team can add expertise in psychology, sociology, construction technology, and design. This facilitates the development of activities and tools and their successful application.

Value delivery emphasises the empowerment of end-users to achieve the objectives of trust and social cohesion. Mutual learning and behaviour change of all stakeholders can be stimulated through LLs in favour of effective decision-making to solve environmental and social problems on a continuous basis. A cautionary guideline relates to stakeholders, such as upgrading promoters and executors, who frequently have hidden agendas. To avoid potential conflict, specific end-user-focused activities are essential to prevent false expectations with growing demands on upgrading projects that increase costs.

In all upgrading processes distinctions should be made between communal area design discussions and individual residential spaces to respect the privacy of users. Insights stress the importance of taking into account home ownership in SH upgrading processes. Tenants are not involved in the planning and design phases. Agents responsible for upgrading processes, such as housing associations or councils decide technical and economic aspects of refurbishment. However, tenants should have a say in upgrading decisions related to aesthetics, and comfort. Renters should also be advised on additional costs to be covered by them for upgrading kitchens and bathrooms, for instance. When residents own SH units privately and housing associations have no obligation to upgrade after a period of legal ownership transfers, individual design assistance is recommended, and community actions should stimulate improvements in public areas.

Different climate contexts impact upgrading goals and should be addressed given climate change. In developing countries, SH design models have been shown to have less than adequate thermal comfort conditions and user-introduced transformations are common (Invidiata & Ghisi, 2016). Under such conditions, especially in tropical countries, thermal comfort conditions need detailed evaluation to avoid increased need for air-conditioning, impacting not only environmental sustainability but also energy costs for low-income families. Refurbishment in developed countries, with cold or temperate climates, primarily addresses cold conditions. This should be carefully assessed, however, to avoid overheating with hotter summers becoming more common due to climate change (Tsoulou et al., 2023; Visconti, 2023; Zahiri & Gupta, 2023).

Refurbishment works cause nuisances, with risks of dust, noise, and loss of privacy. These can create conflicts between construction workers and residents, hampering efficient refurbishments. Information on the upgrading process is essential to gain trust and mitigate conflict during construction. Also, the need for temporary housing to avoid risks should

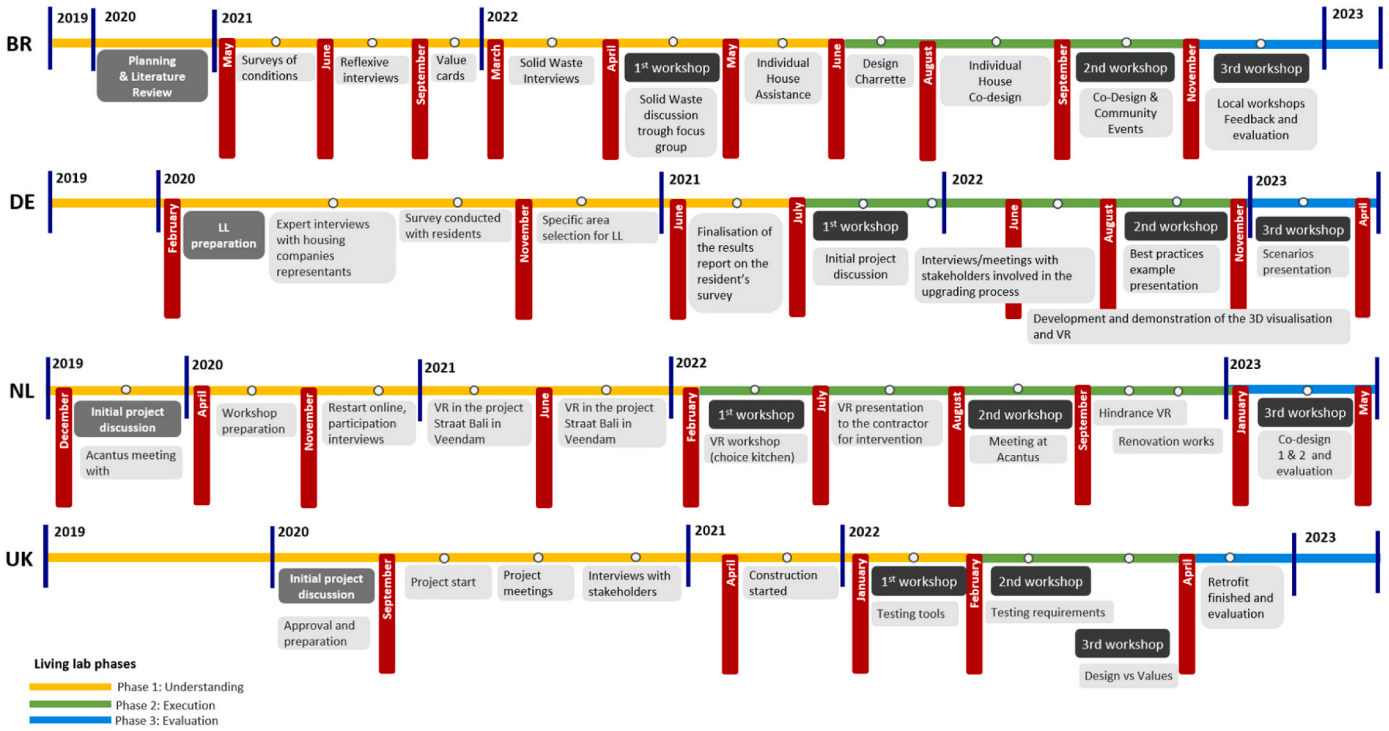

Fig. 5. Timelines of LLs in three phases developed in four countries.

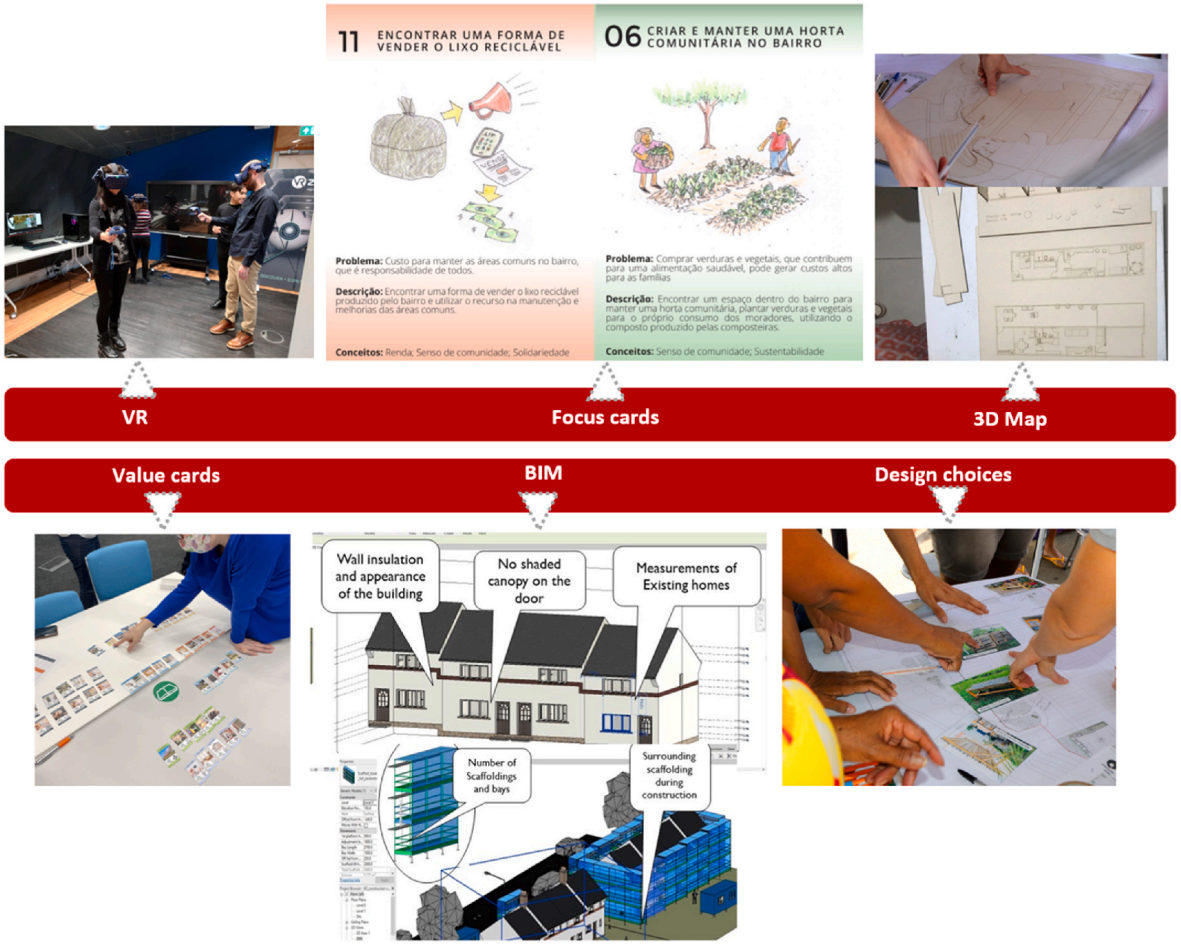

Fig. 6. Tools applied in Living Lab events (Source: The authors).

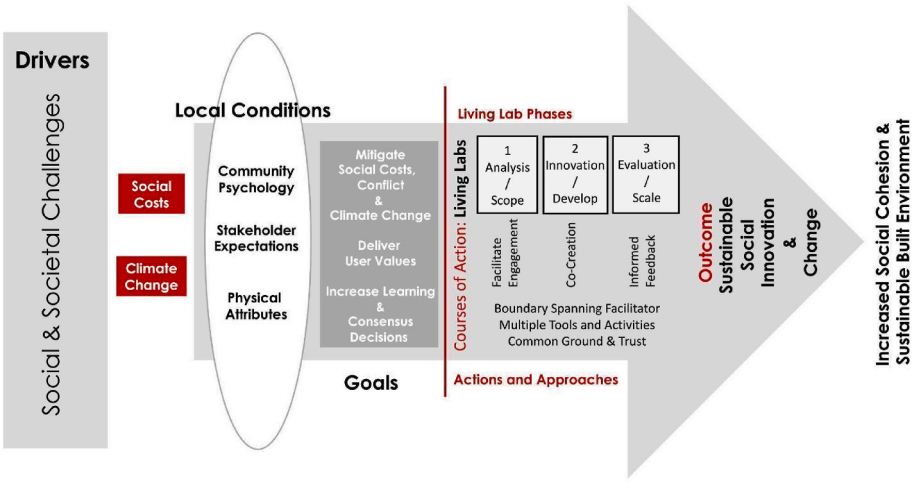

Fig. 7. Conceptual guiding framework for social housing upgrading processes through Living Labs based on research results and Fasshauer (2022), Kæseler et al. (2019), van Geenhuizen (2018 and 2019), Smith and Iversen (2018) and van der Have and Rubalcaba (2016) (Source: The authors).

be assessed through careful modeling of construction activities in the actual housing reality.

For SH upgrading the revitalisation of gardens should be a common ground topic for LLs and co-design sessions. As a source of nuisance, a further common interest topic should include solid waste management. Priority given to green area refurbishment can bring up questions about healthy and sustainability-conscious living and can be shown to tackle issues of social cohesion in multifamily housing. People need to feel comfortable and secure to socially interact and enjoy outdoor spaces, but annoyances from shared use should be avoided. Targeting communal area (re)design in co-design is crucial because collective well-being manifests itself in settings where strong social cohesion regarding shared issues exists (Berger, 2018; Fonseca et al., 2019; Jennings & Bamkole, 2019). Well-kept gardens also increase the satisfaction of SH residents with their home environment (Jennings & Bamkole, 2019). Biophilia is an engrained love of humans for nature, and there is an appeal for people to live close to attractive natural environments (McVay et al., 1993). Also, there is more agreement for natural landscape stimuli than for the built environment (Weinberger et al., 2021).

6. Conclusions

This article discussed SH upgrading through case studies that applied LLs. The cases were conducted in Brazil, Germany, the Netherlands, and the UK. Our research questions related to the sequence of events and tools that may lead to efficient upgrading processes with informed decision-making. We also addressed the extent to which user empowerment can meet user needs with value delivery and how contextual conditions affect the processes in LLs to upgrade SH.

A theoretical framework to guide LL conceptualisation and setting for SH upgrading is offered. Contextual drivers and specific local conditions and goals broadly frame 3-phased LL settings, which are finely tuned based on tools and activities recommended for boundary spanning and gaining common ground and trust. Infused with the case study outcomes, it can be customised and complemented by a detailed list of recommendations to address specific needs.

Our results contribute to knowledge regarding participatory processes by confirming the power of LLs based on drivers, goals, and desired outcomes. This is shown for the four cases, in particular, but can be generalised to various contexts and specifically adjusted, as needed. Case study goals were achieved, with results according to local contexts. Collaboration occurred between end-users and the academic teams. Collaboration mechanisms were primarily the reflexive interviews, co-design, design charrettes, open communication channels, workshops and focus groups. The improvement of gardens was the common ground issue in all cases.

Perception of the built environment increased. In Europe, users gained a stronger voice to indicate their needs and desires and were made aware of the refurbishment process. In Brazil, social engagement increased, with potential community actions to improve public areas. Individual owners gained design solutions for house reforms.

To promote smooth-running processes and user value delivery, the preparation of LL activities and tools is essential to gain trust, guarantee early user engagement, and avoid conflict. Tools for visualising design choices and the upgrading process do not have to be necessarily sophisticated; rather, they must stimulate interaction, support co-design, and be well-prepared, attractive, and intuitive to use. Frequent events with varied activities and feedback keep engagement alive and maintain trust.

The Dutch and Brazilian cases achieved similar engagement levels, through different approaches, regardless of contextual diversity. In the case of the Netherlands and Germany, with initial top-down processes, the LLs exerted bottom-up pressures on major players, mainly the housing associations, to prioritise the well-being of users. This was less apparent in the UK, as the LL was post hoc, reinforcing that the management of expectations is complex.

In the Brazilian case, through a bottom-up approach, valuable lessons were learned. Social cohesion and interest in the users' home environment increased. The mainly top-down approaches, applied in the European case studies, were more encompassing as contact with users by the academic team was through agencies. In Europe, housing associations and building companies prioritise efficient upgrading operations and solving technical context-situated issues, however, with diminished importance given to social change gains. Multiagent stakeholder participation should therefore be reinforced, and further studies are necessary to enable vibrant LL events with all interested parties.

As a result of the extensive involvement with end-users in these four cases, SH managing stakeholders asked the academic team for follow-up studies. This demonstrates that our transatlantic collaboration achieved positive results and unique lessons were learned. Tool development was shared, with adaptations for specific contexts. Lessons learned, especially for Brazil, are the need to introduce mandatory refurbishment for SH with construction processes that value user involvement through open communication channels. For the European cases, overheating in hotter summers was identified as a problem with refurbishing programmes concentrating primarily on improving constructions for cold winters.

We also learned to stimulate long-lasting relationships and

Table 1
Recommendation Guidelines from case study insights (origin & applicability).

#	Categories and Issues	Original LL	Context Applicability
1.0	**Managing LLs**		
	Adopt the three LL phases	BR, DE, NL, UK	BR, DE, NL, UK
	Contain expectations of stakeholders	BR, UK	BR, DE, NL, UK
	Open communication channels	DE, NL	DE, NL, UK
	Apply sequence of events	BR, NL	BR, DE, NL, UK
	Adopt creative engagement activities	BR, NL, UK	BR, DE, NL, UK
	Timing in appropriate intervals	BR	BR, DE, NL, UK
	Start before construction	NL	DE, NL, UK
	Involve children	BR	BR, DE, NL, UK
	Conduct academic-led LLs with end-users	BR, NL, UK	BR, DE, NL, UK
	Adopt a flexible approach	BR, DE, NL, UK	BR, DE, NL, UK
	Acknowledge limited practical knowledge of academic teams	NL	BR, DE, NL, UK
	Devise funding systems to promote LLs	BR	BR
	Avoid policy & construction workflow-driven LLs	NL	DE, NL, UK
	Assure commitment to the project by executing stakeholder	NL	BR, DE, NL, UK
	Align LL activities with the upgrade process	UK	DE, NL, UK
	Focus on reality & priorities	BR, NL, UK	BR, DE, NL, UK
	Consider conflicting agendas of stakeholders	BR, NL, UK	BR, DE, NL, UK
	Promote constant stimulus	NL	BR, DE, NL, UK
	Make users protagonists after empowerment	NL	DE, NL, UK
	Build long-lasting relationships	BR, DE, NL	BR, DE, NL, UK
2.0	**Mitigating conflict, gaining trust, achieving end-user empowerment & social cohesion**		
	Reflexive, initial interviews	BR, NL	BR, DE, NL, UK
	Stimulate trust in the first engagement	BR, NL	BR, DE, NL, UK
	Measure existing conflicts	BR, UK	BR, DE, NL, UK
	Identify priorities	BR, DE, NL, UK	BR, DE, NL, UK
	Respect the privacy of users	DE, NL	BR, DE, NL, UK
	Consider the vulnerability of users	DE, NL	BR, DE, NL, UK
	Consider nuisances of construction works	DE, NL	DE, NL, UK
	Use VR in the first meeting	NL	NL, UK
	Visualise the upgrading process	NL	DE, NL, UK
	Reach out to target groups	BR, DE, NL, UK	BR, DE, NL, UK
	Increase social organisation of users	BR	BR, DE, NL, UK
	Consider and involve users individually	NL	BR, DE, NL, UK
	Include a trusted person or facilitator	DE	DE, NL, UK
	Support solidarity among users	BR, NL	BR, DE, NL, UK
	Gauge empowering differences between stakeholders	NL	DE, NL, UK
	Make users protagonists of their actions	NL	BR, DE, NL, UK
	Promote delivery of values (social, economic, societal)	BR	BR, DE, NL, UK
	Build on long-standing engagement	DE	DE
3.0	**Informed decision-making & collective learning**		
	Prioritise end-user	BR, NL, UK	BR, DE, NL, UK
	Discuss real conditions	BR, NL	BR, DE, NL, UK
	Limit involvement of users in technical issues	NL	BR, DE, NL, UK
	Provide informed feedback	BR	BR
	Increase stakeholders' perceptions of their own environment.	BR, NL, UK	BR, DE, NL, UK
	Promote co-design of common ground issues	BR, NL, UK	BR, DE, NL, UK
	Understand the complexity of building renovations	NL, UK	DE, NL, UK
	Discuss environmental comfort conditions	BR	BR
	Discuss energy efficiency	BR, DE, NL, UK	BR, DE, NL, UK
	Discuss solid waste management	BR, DE, NL, UK	BR, DE, NL, UK
	Discuss health conditions & individual benefits	DE	BR, DE, NL, UK
	Trigger actions in favour of social values	DE, NL	BR, DE, NL, UK
	Discuss property valuation through upgrading.	BR	BR
4.0	**Context-driven activities & tools**		
	Visualise housing reality	NL, UK	BR, DE, NL, UK
	Analyse user group specifics (Health conditions, education level)	BR, DE, UK	BR, DE, NL, UK
	Consider equipment available	NL	BR, DE, NL, UK
	Consider available funds	NL	BR, DE, NL, UK
	Distinguish between tenants and owners	BR	BR, DE, NL, UK
	Consider context climate	BR, DE, NL, UK	BR, DE, NL, UK
	Visualise potential solutions	BR, NL, UK	BR, DE, NL, UK
	Use focus cards to manage group discussions	BR	BR, DE, NL, UK
	Adapt tools & activities to the specific interests of participants	BR, DE, NL, UK	BR, DE, NL, UK
	Prefer visualisation tools	BR, DE, NL, UK	BR, DE, NL, UK
	Apply simple (analogue) and sophisticated (digital) tools	BR, UK	BR, DE, UK
	Avoid the use of BIM	UK	BR, DE, NL, UK
	Avoid CAVE visualisations.	UK	BR, DE, NL, UK
5.0	**Delimitation of scope**		
	Address private residential spaces and communal areas separately	BR, NL	BR, DE, NL, UK
	Priorities semi-public spaces	BR, DE, NL, UK	BR, DE, NL, UK
	Focus community attention on green areas (gardens)	BR, DE, NL, UK	BR, DE, NL, UK
6.0	**Triggering essential questions**		
	Climate change	BR, DE, NL, UK	BR, DE, NL, UK
	Officially funded programmes for energy efficiency	BR	BR
	New ways of living	BR	BR, DE, NL, UK
	Envisioning the future	NL	BR, DE, NL, UK
	Local conditions	BR, NL	BR, DE, NL, UK

(Source: The authors)

acknowledged that an academic attitude may often have limited practical knowledge, but can achieve rich engagements by reducing annoyances, organising early events with attractive tools to visualise ideas, as well as with attitudes of open-mindedness and humility. Co-design activities through charrettes, drawings and VR reinforced the application of realistic approaches for user collaboration.

The joint investigation confirms that the outcome of LLs depends on going beyond engagement to empower diverse stakeholders as co-agents with long-term commitments towards better living conditions in SH environments. All LLs succeeded in engaging residents, but lasting effects could not be affirmed, thus follow-up studies are indicated. For being an exploratory multiple case study, results are limited to theoretical constructs. Future research should validate guiding recommendations to increase the applicability of results to broader contexts.

Funding

Removed for blind review.

CRediT authorship contribution statement

D.C.C.K. Kowaltowski: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **V. Gomes da Silva:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft,

Writing – review & editing. **C. Van Oel:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Writing – review & editing. **A.D. Granja:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **E.A.D. Muianga:** Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. **S. Kabisch:** Conceptualization, Funding acquisition, Investigation, Methodology, Writing – review & editing. **D. De Carvalho Moreira:** Conceptualization, Data curation, Investigation, Methodology, Visualization, Writing – review & editing. **J.S.J. Koolwijk:** Investigation, Methodology, Writing – review & editing. **J. Pößneck:** Investigation, Methodology, Writing – review & editing. **P.T. Tzortzopoulos:** Conceptualization, Investigation, Methodology, Writing – review & editing. **J. Soliman Jr:** Investigation, Methodology, Writing – review & editing. **M.E. Bridi:** Investigation, Methodology, Writing – review & editing. **A. Freeke:** Investigation, Methodology, Writing – review & editing.

Declaration of competing interest

None.

Acknowledgements

The authors would like to thank all the organisers and participants of the LLs for their contributions.

References

ACE, A. C. of E. (2022). *For affordable & quality housing (affordable housing activation forum*. ace–cae. eu Architects' Council of Europe.

Alba-Rodríguez, M. D., Martínez-Rocamora, A., González-Vallejo, P., Ferreira-Sánchez, A., & Marrero, M. (2017). Building rehabilitation versus demolition and new construction: Economic and environmental assessment. *Environmental Assessment Review, 66*, 115–126.

Banathy, B. H. (1996). *Designing social systems in a changing world*. New York: Plenum.

Berger, P. L. (2018). *The limits of social cohesion: Conflict and mediation in pluralist societies*. Routledge.

Bridi, M. E., Soliman-Junior, J., Granja, A. D., Tzortzopoulos, P., Gomes, V., & Kowaltowski, D. C. C. K. (2022). Living labs in social housing upgrades: Process, challenges and recommendations. *Sustainability, 14*(5), 5. https://doi.org/10.3390/su14052595.

Broadbent, J. (2003). Generations in design methodology. *The Design Journal, 6*(1), 2–13. https://doi.org/10.2752/146069203790219335

Broadbent, G., & Ward, A. (1969). *Design methods in architecture*. Lund Humphries.

BSI. (2020). *PAS 2035:2019 retrofitting dwellings for improving energy efficiency specification and guidance*. London - UK.

Buchanan, R. (1992). Wicked problems in design thinking. *Design Issues, 8*(2), 5–22.

Buckley, R. M., Kallergis, A., & Wainer, L. (2016). The emergence of large-scale housing programs: Beyond a public finance perspective. *Habitat International, 54*(3), 199–209. https://doi.org/10.1016/j.habitatint.2015.11.022

Buhl, J., von Geibler, J., Echternacht, L., & Linder, M. (2017). Rebound effects in Living Labs: Opportunities for monitoring and mitigating re-spending and time use effects in user integrated innovation design. *Journal of Cleaner Production, 151*, 592–602.

Castellazzi, L., Zangheri, P., Paci, D., Economidou, M., Labanca, N., Ribeiro Serrenho, T., & Broc, J. (2019). Assessment of second long-term renovation strategies under the Energy Efficiency Directive. In *Joint research centre (JRC) for policy report*. the European Commission. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC114200/kjna29605enn.pdf.

Chileshe, N., Khatib, J. M., & Farah, M. (2013). The perceptions of tenants in the refurbishment of tower blocks. *Facilities, 31*(3/4), 119–137. https://doi.org/10.1108/02632771311299403

Coyne, B., Lyons, S., & McCoy, D. (2018). The effects of home energy efficiency upgrades on social housing tenants: Evidence from Ireland. *Energy Efficiency, 11*, 2077–2100. https://doi.org/10.1007/s12053-018-9688-7

Crawford, K., Johnson, C. E., Davies, F., Joo, S., & Bell, S. (2014). Demolition or refurbishment of social housing? A review of the evidence. In *UCL urban lab and engineering exchange*. London, UK: UCL Urban Lab and Engineering Exchange [Report].

Cross, N. (1993). Science and design methodology: A review. *Research in Engineering Design, 5*(2), 63–69. https://doi.org/10.1007/BF02032575

Cross, N. (2007). *Designerly ways of knowing* (1 edition). Birkhäuser Architecture.

Dell'Era, C., & Landoni, P. (2014). Living lab: A methodology between user-centred design and participatory design. *Creativity and Innovation Management, 23*(2), 137–154. https://doi.org/10.1111/caim.12061

Cognetti, F. (2023). Beyond a buzzword: Situated participation through socially oriented urban living labs. In N. Aernouts, F. Cognetti, & E. Maranghi (Eds.), *Urban living lab for local regeneration: Beyond participation in large-scale social housing estates* (1st ed., pp. 19–38). Springer Nature https://library.oapen.org/handle/20.500.12657/59379.

Directive (EU) 2023/1791 of the European parliament and of the council of 13 september 2023 on energy efficiency and amending regulation (EU) 2023/955 7, EP, CONSIL, 231 OJ L (2023). http://data.europa.eu/eli/dir/2023/1791/oj/eng.

Droste, C., & Knorr-Siedow, T. (2014). Social housing in Germany. In K. Scanlon, C. Whitehead, & M. F. Arrigoitia (Eds.), *Social housing in Europe* (1st ed., pp. 183–202). Wiley. https://doi.org/10.1002/9781118412367.ch11.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of Management Journal, 50*(1), 25–32. https://doi.org/10.5465/amj.2007.24160888

Europe, H. (2023). The state of housing in Europe 2023. https://www.stateofhousing.eu.

Fasshauer, I. (2022). Value co-creation and social innovation: The example of living labs. *Décisions Marketing, 108*(October-December), 223–237.

Fonseca, X., Lukosch, S., & Brazier, F. (2019). Social cohesion revisited: A new definition and how to characterize it. *Innovation: The European Journal of Social Science Research, 32*(2), 231–253.

Gnecco, V., Guarda, E., Ordenes, M., & Lamberts, R. (2022). Overheating risk in naturally ventilated and conditioned elementary schools from the perspective of climate change. *Will Cities Survive?*, 1–6.

Gsenger, R., Human, S., & Neumann, G. (2020). *End-user empowerment: An interdisciplinary perspective*. HICSS. https://core.ac.uk/download/pdf/326835688.pdf.

Gustavsson, E., & Elander, I. (2016). Sustainability potential of a redevelopment initiative in Swedish public housing: The ambiguous role of residents' participation and place identity. *Progress in Planning, 103*, 1–25. https://doi.org/10.1016/j.progress.2014.10.003

Hards, S. K. (2013). Status, stigma and energy practices in the home. *Local Environment, 18*(4), 438–454. https://doi.org/10.1080/13549839.2012.748731

Heylighen, A., & Dong, A. (2019). To empathise or not to empathise? Empathy and its limits in design. *Design Studies, 65*, 107–124.

Hossain, M., Leminen, S., & Westerlund, M. (2019). A systematic review of living lab literature. *Journal of Cleaner Production, 213*, 976–988. https://doi.org/10.1016/j.jclepro.2018.12.257

Hossu, C.-A., Oliveira, E., & Niță, A. (2022). Streamline democratic values in planning systems: A study of participatory practices in European strategic spatial planning. *Habitat International, 129*, Article 102675.

Invidiata, A., & Ghisi, E. (2016). Impact of climate change on heating and cooling energy demand in houses in Brazil. *Energy and Buildings, 130*, 20–32. https://doi.org/10.1016/j.enbuild.2016.07.067

Jennings, V., & Bamkole, O. (2019). The relationship between social cohesion and urban green space: An avenue for health promotion. *International Journal of Environmental Research and Public Health, 16*(3), 452.

Kamarulzaman, P. N., Azmi, N. F., & Sulaiman, R. (2019). A review of constraint factors in complying with building control regulations related to house renovation. *Journal of Surveying, Construction and Property, 10*(1), 57–62. https://doi.org/10.22452/jscp.vol10no1.5

Kapp, K. W. (1970). Environmental disruption and social costs: A challenge to economics. *Kyklos, 23*(4), 833–848.

Kabisch, S., Poessneck, J., Soeding, M., & Schlink, U. (2022). Measuring residential satisfaction over time: Results from a unique long-term study of a large housing estate. *Housing Studies, 37*(10), 1858–1876. https://doi.org/10.1080/02673037.2020.1867083.

Kæseler, S. M., Neve, H. H., Wandahl, S., & Jensen, S. R. (2019). Towards developing a framework for user-driven innovation in refurbishment. In I. Lill, & E. Witt (Eds.), *Emerald reach proceedings series* (pp. 427–435). Emerald Publishing Limited. https://doi.org/10.1108/S2516-285320190000002016.

Koolwijk, J. (2022). Rules, Power and Trust: Interplay between inter-organizational structures and interpersonal relationships in project-based organizations in the construction industry. *A+ BE| Architecture and the Built Environment, 01*, 1–174.

Kowaltowski, D. C. C. K. (1980). *Humanization in architecture: Analysis of themes through highschool building problems*. Berkeley: UCB - University of California.

Kowaltowski, D. C. C. K., da Silva, Pina, S. A., Labaki, L. C., Ruschel, R. C., & de Carvalho Moreira, D. (2006). Quality of life and sustainability issues as seen by the population of low-income housing in the region of Campinas, Brazil. *Habitat International, 30*(4), 1100–1114.

Kowaltowski, D. C. C. K., & Granja, A. D. (2011). The concept of desired value as a stimulus for change in social housing in Brazil. *Habitat International, 35*(3), 435–446. https://doi.org/10.1016/j.habitatint.2010.12.002.

Kowaltowski, D. C. C. K., Muianga, E. A. D., Granja, A. D., Moreira, D. de C., Bernardini, S. P., & Castro, M. R. (2019). A critical analysis of research of a mass-housing programme. *Building Research and Information, 47*(6), 716–733. https://doi.org/10.1080/09613218.2018.1458551.

Lapointe, D., Guimont, D., Guillemard, A., & Benjamin, C. (2021). People, place, values: Living lab as social innovation processes for tourism communities. *Anais brasileiros de Estudos turísticos*. https://doi.org/10.5281/zenodo.5771002

Leminen, S., Rajahonka, M., & Westerlund, M. (2017). Towards third-generation living lab networks in cities. *Technology Innovation Management Review, 7*(11), 21–35. https://doi.org/10.22215/timreview/1118

Luck, R. (2018). Participatory design in architectural practice: Changing practices in future making in uncertain times. *Design Studies, 59*, 139–157.

McVay, S., Katcher, A., McCarthy, C., Wilkins, G., Ulrich, R., Shepard, P., Antoine, S. S., Diamond, J., Orians, G., Nelson, R., Gadgil, M., Margulis, L., & Lawrence, E. (1993). In S. R. Kellert, & E. O. Wilson (Eds.), *1a edição)The biophilia hypothesis*. Shearwater.

Monroe, K. B. (1990). *Pricing: Making profitable decisions (2 sub)*. Mcgraw-Hill College.

Mulgan, G., Tucker, S., Ali, R., & Sanders, B. (2007). *Social Innovation—what it is, why it matters and how it can be accelerated*. Oxford SAID Business School [Working paper].

Muianga, E. A. D., Kowaltowski, D. C. C. K., Silva, V. G. da, Moreira, D. de C. M., Granja, A. D., Oliva, C. A., & Silva, R. F. da (2021). Critical analysis of housing condition impacts on residents' well-being and social costs. *Gestão & Tecnologia de Projetos, 16*(4), Article 4. https://doi.org/10.11606/gtp.v16i4.178511

Muianga, E. A. D., Kowaltowski, D. C. C., Silva, V. G. da, Granja, A. D., Moreira, D. de C., & Ruschel, R. C. (2022). Housing transformations and their impacts on the well-being of dwellers. *Ambiente Construído, 22*, 255–274. https://doi.org/10.1590/s1678-86212022000400639.

Oorschot, L., Spoormans, L., El Messlaki, S., Konstantinou, T., De Jonge, T., Van Oel, C., Asselbergs, T., Gruis, V., & De Jonge, W. (2018). Flagships of the Dutch welfare state in transformation: A transformation framework for balancing sustainability and cultural values in energy-efficient renovation of postwar walk-up apartment buildings. *Sustainability, 10*(7), 1–22. https://doi.org/10.3390/su10072562

Patton, M. Q. (2014). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). SAGE Publications Ltd.

Poortinga, W., Jones, N., Lannon, S., & Jenkins, H. (2017). Social and health outcomes following upgrades to a national housing standard: A multilevel analysis of a five-wave repeated cross-sectional survey. In *BMC public health* (Vol. 17). BioMed Central Ltd. https://doi.org/10.1186/s12889-017-4928-x

Power, A. (2008). Does demolition or refurbishment of old and inefficient homes help to increase our environmental, social and economic viability? *Energy Policy, 36*(12), 4487–4501. https://doi.org/10.1016/j.enpol.2008.09.022

Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999, 243 OJ L (2021). http://data.europa.eu/eli/reg/2021/1119/oj/eng.

Schuler, D., & Namioka, A. (Eds.). (1993). *Participatory design: Principles and practices* (1st ed.). CRC/Lawrence Erlbaum Associates.

Scuderi, G. (2019). Retrofit of residential buildings in Europe. *Design, 3*(1). https://doi.org/10.3390/designs3010008. Article 1.

Serapião, F. (2016). Linking the formal and informal: Favela urbanisation and social housing in São Paulo. *Architectural Design, 86*(3), 70–79. https://doi.org/10.1002/ad.2048

Smith, R. C., & Iversen, O. S. (2018). Participatory design for sustainable social change. *Design Studies, 59*, 9–36. https://doi.org/10.1016/j.destud.2018.05.005

Soliman-Junior, J., Awwal, S., Tzortzopoulos, P., Ayo-Adejuyigbe, M., & Kagioglou, M. (2022). *Eliciting requirements in social housing retrofit projects: Tools and processes within a living lab setting* (pp. 468–479). https://iglc.net/papers/Details/1980.

Stenberg, J. (2018). Dilemmas associated with tenant participation in renovation of housing in marginalized areas may lead to system change. *Cogent Social Sciences, 4*(1), 1–22. https://doi.org/10.1080/23311886.2018.1528710

Szymanski, L., Szymanski, H., & Fachim, F. L. (2019). Interpretação como desocultamento: Contribuições do pensamento hermenêutico e fenomenológico-existencial para análise de dados em pesquisa qualitativa. *Pro-Posições, 30*, 1–25.

Thomson, H., Thomas, S., Sellström, E., & Petticrew, M. (2013). *Housing improvements for health and associated socio-economic outcomes: A systematic review (2013:2; campbell collaborations* (pp. 1–348). https://onlinelibrary.wiley.com/doi/abs/10.4073/csr.2013.2.

Tipple, G. (2000). *Extending Themselves: User-initiated transformations of government built housing in developing countries*. University of Liverpool Press.

Tsoulou, I., He, R., Senick, J., Mainelis, G., & Andrews, C. J. (2023). *Monitoring summertime indoor overheating and pollutant risks and natural ventilation patterns of seniors in public housing, 1420326X2211487*. Indoor and Built Environment. https://doi.org/10.1177/1420326X221148728

Umeh, K., Ezeji, K., & Agoha, B. (2023). The engagement of built-environment professionals, A factor for improving housing transformation in public housing estates in owerri, Nigeria. *Coou African Journal of Environmental Research, 4*(1). Article 1.

van der Have, R. P., & Rubalcaba, L. (2016). Social innovation research: An emerging area of innovation studies? *Research Policy, 45*(9), 1923–1935. https://doi.org/10.1016/j.respol.2016.06.010

van Geenhuizen, M. (2018). A framework for the evaluation of living labs as boundary spanners in innovation. *Environment and Planning C: Politics and Space, 36*(7), 1280–1298. https://doi.org/10.1177/2399654417753623

van Geenhuizen, M. (2019). Applying an RRI filter in key learning on urban living labs' performance. *Sustainability, 11*(14). https://doi.org/10.3390/su11143833. Article 14.

Vilches, A., Padura, A. B., & Huelva, M. M. (2017). Retrofitting of homes for people in fuel poverty: Approach based on household thermal comfort. *Energy Policy, 100*, 283–291. https://doi.org/10.1016/j.enpol.2016.10.016

Visconti, C. (2023). Co-production of knowledge for climate-resilient design and planning in Naples, Italy. *Habitat International, 135*, Article 102748.

Watson, K. J., Evans, J., Karvonen, A., & Whitley, T. (2016). Re-Conceiving building design quality: A review of building users in their social context. *Indoor and Built Environment, 25*(3), 509–523.

Weinberger, A. B., Christensen, A. P., Coburn, A., & Chatterjee, A. (2021). Psychological responses to buildings and natural landscapes. *Journal of Environmental Psychology, 77*, Article 101676.

Yang, H., Chen, X., & Zelinsky, G. J. (2009). A new look at novelty effects: Guiding search away from old distractors. *Attention, Perception, & Psychophysics, 71*(3), 554–564. https://doi.org/10.3758/APP.71.3.554

Yin, R. K. (2013). *Case study research: Design and methods* (5th ed.). edição: Sage Publications, Inc.

Zahiri, S., & Gupta, R. (2023). Examining the risk of summertime overheating in UK social housing dwellings retrofitted with heat pumps. *Atmosphere, 14*(1617), 2–26, 10.3390.