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Social housing upgrading actions beyond energy efficiency

Ações em prol de melhorias na habitação social além da eficiência energética.

Elisa Atália Daniel Muianga
Universidade de São Paulo | São Paulo | Brasil | emuianga@usp.br
Doris Catharine Cornelie Knatz Kowaltowski
Universidade Estadual de Campinas | Campinas | Brasil | doris@unicamp.br

Abstract

Social Housing (SH) upgrading is globally recommended, primarily through mandatory upgrading programmes. Most upgrading programmes address energy efficiency and measures to mitigate climate change through deep invasive processes. However, upgrading programmes should expand beyond energy efficiency, particularly in developing countries, as a way to mitigate social cost linked to the SHs. Our study seeks to identify opportunities concerning the execution of upgrading. Improvements through a non-mandatory upgrading process for a specific SH example, the "Residential *Quilombo*" in the city of Campinas, are presented. The study uses an exploratory-descriptive approach. Results highlight the importance of requalifying SH through upgrading with practical implications, especially in Brazil. Participatory processes are indicated to empower users with information and to define priorities to improve the quality of life and well-being of people.

Keywords: Social Housing. Upgrading. Retrofit. Requalification. Social Cost.

Resumo

Upgrading em Habitação Social (HS) são mundialmente recomendados, principalmente em processos mandatórios de melhorias. A maioria dos programas de upgrading abordam sobre a eficiência energética e medidas para mitigar as alterações climáticas, com processos de melhorias amplos. Contudo, processos de melhorias devem ser extrapolados além da eficiência energética, especialmente em países em desenvolvimento, como forma de reduzir custos sociais associados às HISs. Assim, a pesquisa busca identificar oportunidades para aplicar melhorias. Um caso de estudo de upgrading de HS do Residencial Quilombo, localizado no município de Campinas, em processo não mandatório, é apresentado nesta pesquisa. A pesquisa é definida como exploratória-descritiva. Resultados evidenciam a importância da requalificação de HS através de upgrading, especialmente no Brasil. Processos participativos são indicados para empoderar usuários com informações, e definir prioridades para melhorar a qualidade de vida e bem-estar das pessoas.

Palavras-chave: Habitação social. Melhorias. Retrofit. Requalificação. Custos Sociais.

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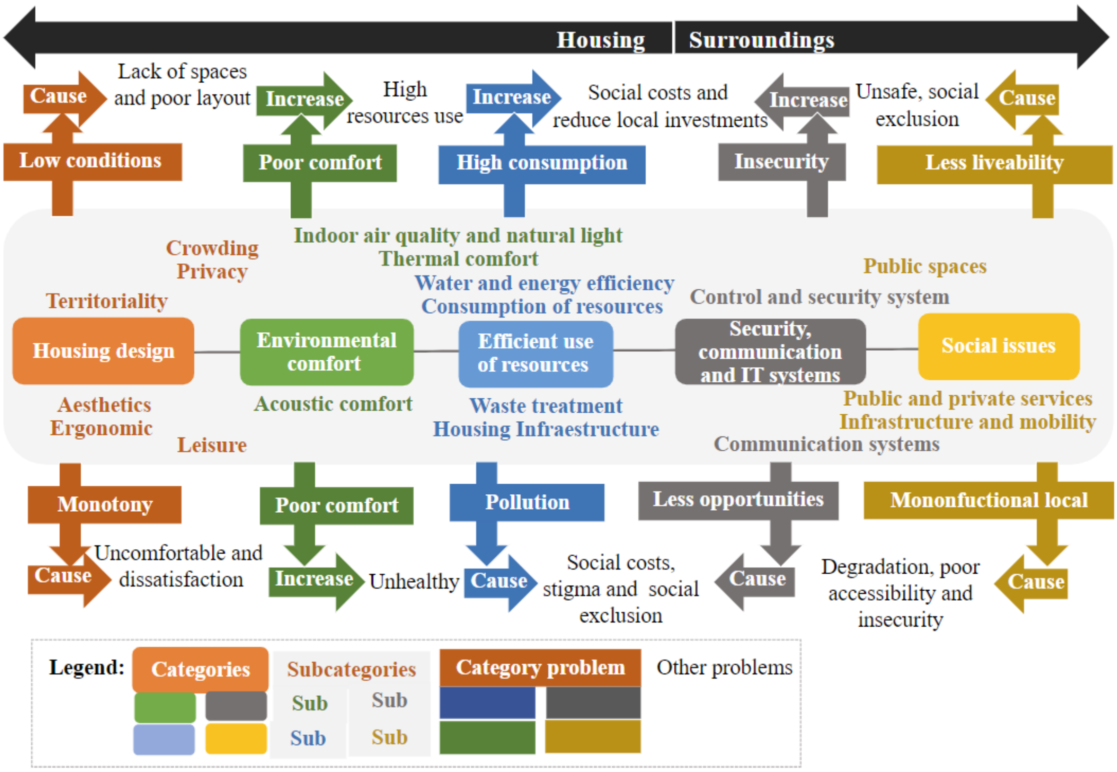
INTRODUCTION

Social Housing (SH) upgrading programmes are recommended worldwide, primarily to mitigate climate change in countries with mandatory processes. These mandatory upgrading processes are driven by energy efficiency objectives. Thus, environmental policies and laws, as top-down initiatives, impose refurbishments for energy efficiency [1]. As a general objective, upgrading should bring housing quality to international standards set by global agendas and overcome recurrent negative impacts of substandard SH to improve residents' quality of life [2].

Upgrading processes may involve different types of interventions to improve the physical aspects of housing for greater suitability and functionality [3]. Interventions may be invasive or deep, or classified as non-invasive or shallow. Refurbishments differ according to sustainability and energy efficiency achievements as well as general improvements of buildings and surroundings [4].

Many SH developments, especially in developing countries, present several problems indicating refurbishment interventions beyond maintenance. Five issues related to housing and surrounding conditions drive the problems and need for upgrading [5]. Figure 1 illustrates these categories and sub-categories concerning the built environment. Common problems should be tackled to mitigate psychological, comfort, functional, economic, infrastructure and social vitality issues in SH as outlined in Figure 1.

Figure 1: SH upgrading problems, and intervention categories



Source: The Authors

Poor housing design with a lack of functional space and faulty layouts can result in inadequate living conditions and monotony of surroundings. Low environmental comfort conditions may lead to health problems and social behavioural issues, as well as excessive use of equipment to improve thermal comfort, ventilation and interior lighting. Water use needs to be optimised and energy efficiency is essential. Poor infrastructure conditions in general may cause pollution. Such problems may increase social costs, indicating social needs. When services are absent in a specific area due to insufficient investment, stigma may increase with reduced job and education opportunities. This in turn increases social costs. Therefore, social issues need to be addressed in SH upgrading projects with local infrastructure in mind.

In mandatory upgrading programmes found in Europe, SH receives significant funding for refurbishment projects to mitigate problems [6]. Most upgrading programmes address energy efficiency and may include construction maintenance demands, through deep invasive processes. Existing literature on refurbishment emphasises energy efficiency, carbon reductions, and measures to mitigate climate change [7]. For older buildings electric and hydraulic infrastructure improvements may be introduced, and kitchen and bathroom refurbishment is common [8].

Social pressures may exist, demanding diverse actions beyond sustainability issues, which cover five pillars: water, waste, energy, the health of the occupants, and materials [2; 4; 9; 10]. Inadequate environmental and social conditions indicate the need for interventions [11; 12]. Fuel poverty, social exclusion, family conflict, and urban violence are recognised factors to consider in upgrading processes [1; 9].

Bottom-up interventions may occur in non-mandatory upgrading processes [2]. These may be instigated by users as transformations that mainly address environmental comfort (ventilation, natural light, and thermal), aesthetics (visual and stigma), functionality (amenities, personalisation, adaptability, space dimensions and additional rooms), and health and security issues, often with reduced sustainability objectives [5].

Low-quality SH may infer social costs (SCs) that reinforce arguments in favour of upgrading [13]. Public refurbishment programmes should therefore be expanded beyond energy efficiency in countries where retrofit is not yet mandatory to mitigate SCs.

RESEARCH QUESTIONS

Our research questions are:

- What are the issues to be tackled in SH beyond energy efficiency issues?
- What actions should be taken to improve SHs in non-mandatory processes, as in the case of Brazil?

The research aims to identify challenges to apply upgrading actions and analyse types of improvements. A specific SH example, the Residential *Quilombo,* in the city of Campinas, is used as a case of a non-mandatory upgrading process.

METHODS

This research is classified as qualitative and quantitative, based on an exploratory-descriptive approach. Exploratory-descriptive research seeks to develop concepts and ideas to formulate new hypotheses [14]. The research was developed in three phases, according to Table 1.

Table 1: Research process

Research Phase	**Aims** ***Method applied***
Phase 1	Identify challenges to apply upgrading in existing SH. *Literature analysis*
Phase 2	Analyse types of upgrading and classify the level of refurbishment (simple /shallow, or invasive). *Literature analysis*
Phase 3	Analyse improvements in a specific SH example, the Residential *Quilombo* in the city of Campinas. *Case study*

Source: The Authors

In phase 1, a systematic literature review was conducted to identify challenges applicable to the upgrading of existing SH. Databases, strings, and a screening process were developed for this study through a protocoled process. Phase 2, classified the challenges for upgrading, to constitute improvement categories and opportunities for their implementation. In phase 3, a case study was conducted to analyse the upgrading opportunities for a Basilian SH example.

DISCUSSION AND RESULTS

A literature analysis assembled upgrading information. For the study sample, words and variations of retrofit, upgrading and refurbishment were identified, as well as SH variations, to constitute strings. Inclusion and exclusion criteria were applied to the screening process. Identifying retrofit in Brazilian SH was essential, therefore, a geographic location filter was applied to identify issues of a specific example.

Word variations and the strings were set up to apply in specific databases (Table 2). Scopus, Web of Science, Scielo and Google Academics were used to gather sample items. Google Academics was used to amplify the search, as important Brazilian information may not be published in the main scientific databases. The main objective was to identify papers covering updating and upgrading issues for SH.

Table 2: Sample analysis

String	**Database**	**Sample 1**
• (Updat* or Upgrad*) and (Maint* or Improv* or Interven*) and (Refurbish* or retrofit or requalifat*) and ("Public hous*" or "low-income hous*" or "Social hous*") • (Updating or upgrading) and (Maintenance or Improvements or Intervention) and (Refurbishment or Retrofit or Requalification) and ("Public housing" or "low-income housing" or "Social housing")	Web of science	38
	Scopus	44
	Google academic	114
Interventions and social housing or public housing	Scielo	43
Retrofit and "habitação social" and brasil	Google academic	32
Total papers (sample 1)		**271**

Source: The Authors

Two hundred and seventy-one (271) articles were identified. Forty-five (45) papers were classified as non-open access publications. After reading the abstracts, one hundred seventy (170) papers were found that did not cover SH upgrading, and fourteen (14) articles were duplicates. As a result, forty-two (42) papers were analysed.

During the analysis of this sample, we identified twenty-eight (28) papers that mentioned retrofit, with some upgrading processes, thus constituting mere intentions.

These articles were removed from the sample. Fourteen (14) studies remained for analysis. Through snowballing, a further three (3) papers were added.

Table 3: Final sample

Sample	qnt	Authors
Other countries SH retrofit	10	10; 15; 16; 17; 18; 19; 20; 21; 22; 23
Brazilian SH retrofit	7	24; 25; 26; 27; 28; 29; 30

Source: The Authors

Few studies report retrofit in SH in Brazil, although seven (7) papers could be found. Ten (10) papers developed in other countries were, however, identified, and are considered important for comparison. In summary, our sample included seventeen (17) papers that were analysed in detail to build our resulting contribution.

PHASE 1: IDENTIFY CHALLENGES AND OPPORTUNITIES TO APPLY UPGRADING IN EXISTING SH

Mandatory upgrading has been applied in Europe in connection with a fairly old SH building stock. Interventions are necessary to upgrade housing estates to current living and technological standards, due to new social and cultural realities [1]. However, the primary issue of upgrading is the decarbonization and energy efficiency of the existing housing stock [31]. Climate change and its impacts threaten the natural ecosystems and human well-being [32].

The environment, economy, and social welfare may benefit from the reduction of the carbon footprint of housing [33]. However, energy retrofitting of existing residential buildings is a challenge, especially in low-income regions, and for SH [20]. Upgrading barriers are primarily economic, informational, behavioural, and administrative [23].

Barriers are related to a range of different and new technologies to reduce carbon emissions and improve energy efficiency. High upfront costs with long payback periods are a particular burden [34]. Information barriers involve regulatory frameworks, new technologies, installations, operations, and the maintenance of efficient equipment that include the quantification of future energy savings [18].

Building energy efficiency is a prerequisite for the upgrading of heating technologies, to reduce carbon emissions associated with electrical systems [32]. For energy policies concerning decarbonisation, energy consumption reduction initiatives may go unheeded in social and physical contexts when the financial costs, habits, behaviour and physical infrastructure are challenged [35].

In developed countries, located in areas with cold winters, low-income households spend a larger proportion of their income on gas and electricity, as older buildings have less efficient appliances and lack insulation [19]. The incentive to reduce energy bills and thus improve fuel poverty through SH upgrading will also increase thermal comfort levels [34]. Government programs need to evaluate intervention costs concerning maintenance, management and consumption for end-users as well as SCs [15].

Studies on buildings characterised as SH that underwent upgrading in Brazil, were identified in the literature. However, little information was found regarding SH upgrading in general in Brazil [24; 27; 28; 29; 30]. Existing upgrading processes presented are, on the whole, poorly detailed concerning specific interventions. Thus, classifications as retrofits are hampered.

In Brazil, upgrading programs for existing SH are lacking, in contrast to European countries where mandatory processes exist. In Brazil and many developing countries, attempts to achieve residents´ desires concerning functionality, comfort and aesthetic aspects of houses, transformations are undertaken through bottom-up actions by users [1].

PHASE 2: ANALYSE TYPES OF UPGRADING AND CLASSIFY THE LEVEL OF APPLICATION (SIMPLE /SHALLOW, OR INVASIVE). LITERATURE ANALYSIS.

Upgrading needs to comply with safety and environmental standards. User needs should be respected [15]. Also, data on existing buildings is essential for decision-making. A building's size, age, social value, and function should be known. User habits should be established [36].

Upgrading actions need to be effective, environmentally acceptable and feasible. The context of SH projects should be analysed. Local climatic conditions, available resources, and legal constraints need to be characterised [17]. Users' cultural and social status should be known to establish behaviour in favour of sustainability.

Official upgrading of SH to date occurs mainly in developed countries and actions identified in this study as presented in Table 4 come from research in those countries. Table 4 categorised these actions and classified whether they are considered deep or shallow interventions.

Table 4: Types of upgrading

<table>
<tr><th>Types of upgrading</th><th>Description</th><th>Deep or shallow upgrading</th></tr>
<tr><td rowspan="5">Energy efficiency</td><td>Heater/cooler maintenance and upgrade, energy efficient HVAC, passive heating/cooling [16; 19]</td><td rowspan="5">Deep upgrading and high cost</td></tr>
<tr><td>Micro-generation systems: photovoltaic system (PV system) on the roof/facades [10; 16; 17; 18; 20]</td></tr>
<tr><td>Application of a mechanical ventilation system with heat recovery [20; 22; 23]</td></tr>
<tr><td>Retrofitting of condensing boilers [19]</td></tr>
<tr><td>Low carbon heating systems such as heat pumps [22]</td></tr>
</table>

Types of upgrading	Description	Deep or shallow upgrading
	Heating system upgrade: Insulation (artic, internal and external wall, cavity wall, roof, floor, ceiling, envelope, rockwool panels [10; 16; 18; 19; 20; 21; 22; 23]	
	Roof (flat Inverted roof material, comprised extruded polyethylene with coated ceramic tiles with cool properties) [16]	
	Coating (self-cleaning photo-catalytic nanotechnology plaster, appropriate for exterior thermal insulation system) [16]	
	LED lighting (replacement of all conventional) [16; 19]	Simple upgrading and less costly
Comfort	Window replacement and use of triple-pane glazing windows were used [16; 20; 22; 17]	Deep upgrading and high cost
	Exterior shading of windows (awnings) [16]	
	Shading system on the east and west side of the building [21]	
Functionality	Changing internal layout of existing building to allow more natural lighting and cross ventilation [21]	
	Use of dry prefab (wooden and metal elements), with low weight and optimum seismic behaviour [15]	
	Integration of replacement of existing equipment, and reparation [17; 19)	
	Installation of dry-wall walls to facilitate adaptability, and reduce the cost of structural reinforcements required for new masonry walls [27]	
	Add balconies, and loggias with independent structure [15]	
	Change of layout dimensions and their surrounding areas [15]	
Visual	Envelope replacement to improve attractivity and recognizable by the users [15]	
Accessibility	Installation of handrails and tactile flooring on ramps in compliance with accessibility standards [29]	Simple upgrading but high cost
Security	Installation of emergency lighting and signage [29]	
	Sealing frames to enclose fixed stairs [29]	
Consumption Control	Installation of individual electricity and gas metres, and collective water metres [29]	

Source: The Authors

Most of the actions presented in Table 4 refer to energy efficiency. In Brazil, some studies present upgrades for accessibility, security, water and energy consumption control and functionality [27; 29]. However, most of these studies lack detailed information on the processes and their actions.

PHASE 3: ANALYSE IMPROVEMENTS FOR THE CASE STUDY, RESIDENCIAL QUILOMBO. CASE STUDY

The housing development called Residential *Quilombo* was built through the Brazilian *Programa de Aceleração do Crescimento* (PAC). The small development is located in the northern region of the city of Campinas, known as *Região dos Amarais*. Ninety-six (96) families from risk areas were moved to the Residential *Quilombo* in 2013.

Figure 2: Images of Quilombo post-occupancy (2013-2022)

2013, Source: cohab-Campinas	2022, Source: The Authors	2022, Source: Google maps

Source: [5]

Our objective was to analyse possible improvements for the *Quilombo* neighbourhood that may be undertaken by residents. In a previous study, the most recurrent transformations in the *Quilombo* residential complex were identified [5]. Table 5 presents the main interventions that occurred. Reasons for these transformations of houses are the small dimensions of rooms, the poor construction quality, and the lack of a bathroom on the upper floor where bedrooms are located. Terraces or leisure spaces were added where the house had direct access to public land. However, only a few families had this opportunity due to the urban layout of the housing development.

Table 5: Transformation set

Area	**Type of transformation**	**Details**
External	Garages	Construction of garages and leisure areas, for barbecues
	Gates and wall	Front wall and gate construction
	Laundry / services	Covered area with floor
	Tree, plants	Sidewalk and outdoor area planting.
	Sidewalk	Paving
	Barbecue	Side or back area
Indoor	Finishes	Walls, floors, stairs: exchange of finishes (painting and floor and wall tiles)
	Windows and doors	Install or change frames
	Fixtures	Fixed furniture, faucets, lighting, sockets

Area	Type of transformation	Details
	Veranda	Construction of one or two more bedrooms and bathrooms, balcony or verandas
	Add rooms and spaces	Increase in space in the kitchen and living room
	Add bathrooms	Between bed rooms

Source: The authors, based on [5]

Residents indicated that child safety and maintenance of public areas constitute their main concerns, with solid waste management also a critical issue [5]. However, other upgrading opportunities exist if Table 4 is applied to the *Quilombo* development. Other possible interventions are shown in Table 6. Simple (shallow) interventions are classified as upgrading (U), and deeper interventions that involve energy efficiency are classified as retrofit (R), Table 6. In this analysis, we indicate the need for technical support, in more complex interventions, while simpler improvements may be executed by users themselves. Furthermore, some interventions should be periodically executed such as painting, for instance, these were classified as having necessary continuity in investments.

Table 6: Possibilities for improvement – case study

Possibilities for improvement	Upgrading (U) or retrofit (R)	Need for evaluation	Investment	Continuity
Adaptable adjacent rooms	U	Technique	High	
Adaptable adjacent bathrooms	U	Technique	High	
Bathroom renovation	U	Technique	Medium	
Bathroom adaptation	U	Technique	Medium	
Wall finishing and painting	U	Technique	Medium	Necessary
Change/installation of door	U	Not	Low	
Change /installation of windows	U	Not	Low	
Subfloor and ceramic floor tiling	U	Not	Low	
Improvements to external common areas	U	Technique	Variable	Necessary
Improvements to street paving	U	Technique	High	
Addition of balconies, and loggias with independent structure	U	Technique	High	
Improvement of neighbourhood lighting	U	Technique	High	
LED lighting upgrading	R	Not	Low	
Exterior shading of windows (awnings)	R	Technique	Low	
Adding shading systems on the east and west side of buildings	R	Technique	High	
Photovoltaic panels (energy consumption reduction)	R	Technique	High	
Solar water heaters (energy consumption reduction)	R	Technique	High	
Natural lighting and cross ventilation improvement through window additions	R	Technique	High	
Envelope replacement to improve attractively and recognizable by the users	R	Technique	Variable	

More green areas in the surrounding area (squares) or maintenance	R	Technique	High	
Institute selective collection and recycling	R	Technique	High	
More shade (planting more trees)	R	Technique	Low	
Light-coloured paving for roads and sidewalks.	R	Technique	High	

Source: The Authors

The assessment of Table 6 identifies the simplest interventions that residents may carry out, such as painting, installing doors and windows, and changing light fixtures to LED lighting. Although residents may, in some cases, finance bathroom renovations and introduce finishings and painting of walls, technical support is often necessary.

According to Table 6, most improvements demand technical analysis, since they involve enlargement of spaces which can affect the comfort and functionality of the dwelling. Also external area actions also need complex planning for decision-making. In addition, actions aimed at energy efficiency and water use reduction, that concern sustainability and environmental comfort, need specialised technical support to effectively mitigate the impacts of climate change. Changing door/windows, light fixtures and floor finishing are considered simple interventions. Most improvements classified as retrofit concern energy efficiency, demanding high investments. However, for non-mandatory processes, where user desires drive improvements, investments vary from low to high. While many retrofit actions are on-time interventions, others demand repeated or continuous actions.

Besides technical assistance, public housing policies should support the more complex transformations to avoid problems with structural safety, functionality, hygienic conditions and building code issues. Improvements that involve energy efficiency require analysis of technical and economic feasibility, with professional assistance for their implementation. Generally, in Brazil, these improvements for SH projects still lack actions from users and public policymakers. As evidenced by recent extreme weather events, the country suffers from the impact of climatic changes, and actions are urgent.

FINAL REMARKS

This research highlighted actions to upgrade SH, especially in Brazil, where retrofitting for energy efficiency and sustainability is not mandatory, although necessary. Upgrading projects carried out in other countries show that actions focus on comfort, aesthetics, functionality, and the reduction of expenses for fuel as well as carbon emissions. Requalification of installations and heating systems are also frequent interventions in SH in developed countries.

Our findings may guide upgrading processes in developing countries without mandatory refurbishment. Countries like Brazil with mild winters do not need heating system retrofitting, however, summer overheating should be tackled and the use of air conditioning reduced through better construction detailing. Better ventilation, shading of openings and roof insulation are important actions.

User needs are often not established before the planning and design phase of a SH development. Users, especially of single-family houses, will therefore introduce changes to their new homes. Rooms are added, especially bathrooms, and finishes are introduced or changed.

Transformations can be substantial, but do not necessarily improve environmental comfort or tackle sustainability issues. Participatory processes are therefore essential to assist in non-mandatory refurbishment processes. Participation of users has long been advocated for preconstruction decision-making, but is also recommended for upgrading of the existing housing stock. Through participatory processes, users may choose improvement actions concerning sustainability, comfort and functionality, thus increasing potential satisfaction with their built environment. Interaction also promotes learning with a sense of belonging and empowerment that may stimulate continuous actions in favour of better living conditions. Active participation in retrofitting processes is essential, as concrete actions are needed to upgrade existing SH for new scenarios. As well as participatory processes, case studies are necessary to identify potential actions for non-mandatory processes. Such studies should characterise in detail the most effective actions that improve living conditions in a sustainable way of low-income populations in developing countries.

Upgrading should consider present and future user needs based on the dynamics of society. Users should be made aware of the urgent need for energy efficiency and the reduction in water consumption. Existing literature concentrates on these issues, but studies concerning the many and varied actions in favour of other user needs and desires are still few and often lack detailing. Overall, the results of this research are limited to actions found in today's databases; they can, however, provide essential insights to establish public policies concerning upgrading of existing SH to mitigate SCs and the devastating impacts of climate change. Finally, identifying problems for SH refurbishment permits public programmes to go beyond essential energy efficiency measures and technical and economic feasibility to improve the quality of life of people, their health conditions and well-being.

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