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Improving Housing Sustainability Through an Innovative Approach

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ABSTRACT

The need for housing has always been a concern for societies throughout history, and for a long time, providing suitable housing has been a challenge not only for individuals but also for governments. Housing is a fundamental human need; however, access remains a significant challenge, especially for low-income families. Rapid urbanization exacerbates this issue and highlights the need for innovative and sustainable housing strategies that can support urban growth and improve living conditions for these families. This literature review examines housing strategies such as mixed-use developments, incremental housing, low-rent housing, retrofitting, micro-housing, co-housing, and green building through a comprehensive literature search and thematic analysis to address housing challenges comprehensively. The findings suggest that these strategies can significantly enhance spatial equity and promote sustainable urban development. This paper contributes to the existing body of knowledge by providing practical recommendations for policymakers, urban planners, and housing advocates, aiming to strengthen inclusive, equitable, and sustainable cities. The study emphasizes that appropriate design techniques, new materials, and technologies not only increase housing sustainability but also enhance affordability by reducing life cycle costs. This research establishes the link between sustainability and affordability in housing design and offers insights that can be adapted and applied in other areas with low-income groups

Introduction

Global demand for housing has increased due to rapid urbanization, economic challenges, high unemployment rates, poverty, and natural disasters related to climate change. Human factors have exacerbated environmental disasters such as floods, rapid population growth, and political unrest. As a result of these factors, the need for housing and safety in Hormozgan remains largely unmet (Ferlito et al., 2022).

One of the most important discussions regarding housing is its sustainability indices. Housing is a fundamental necessity closely tied to human life, directly impacting individuals (Yip et al., 2017). Housing studies are interdisciplinary, rooted in various sciences, including sociology, economics, technology, policy studies, building engineering, and urban design (Mete, 2020). Affordable housing also struggles with high levels of energy waste, inefficient water use, and a significant carbon footprint. Unsustainable performance in housing delivery is compounded by a lack of passive design principles and the use of appropriate materials and techniques.

In building engineering and urban design, a shortage of residential land supply results in issues such as poor adherence to open residential spaces, violation of allowable heights, non-compliance with occupancy limits, and unauthorized expansions, which severely affect the structural sustainability of residential neighborhoods (Yakob et al., 2012). Socially, urban growth disrupts human structures in urban neighborhoods, leading to social segregation within these areas (Ali-Hasabi et al., 2011). Economic indicators of housing also represent various economic aspects of housing quantitatively, enabling comparison and analysis. In this context, macroeconomic crises significantly impact the sustainability of these indicators.

Affordable housing faces challenges with high levels of energy waste, inefficient water consumption, and a high carbon footprint. Unsustainable performance in housing delivery is exacerbated by a lack of passive design principles and the use of appropriate materials and techniques.

By examining the various dimensions of housing significance, we conclude that sustainable housing is characterized by availability, quality, affordability, and comfort (Tupenaite et al., 2017). In this regard, governments and planning authorities worldwide require more comprehensive methods to evaluate the sustainability of complex housing development systems for future housing planning strategies.

Therefore, the gap in delivering sustainable housing necessitates an acceptance of innovation that enhances construction speed and quality, ensures building sustainability, and reduces waste. This study is a pioneering effort that addresses a significant gap in the literature by exploring the conceptual understanding of sustainability in Sistan and Baluchestan and its practical application for affordable housing. With a particular focus on this intersection, the aim of this study is to provide valuable insights into the relationship between sustainability and affordability in housing design. What sets this research apart is its comprehensive examination of these interconnected elements, offering a holistic perspective that transcends a unique emphasis on either sustainability or affordability. This study approached enhancing the sustainability of affordable housing through innovative strategies.

1. Theoretical Framework

- **Definition of Sustainable Housing**

Sustainable housing is an emerging field of economic knowledge (Gbadegesin and Marais, 2020). Researchers believe that the sustainability aspect of affordable housing has largely been overlooked due to insufficient incentives for developers, alongside restrictive regulatory and policy challenges (Collins et al., 2022). This often results in the construction of substandard and unsustainable housing that becomes costly to maintain in the long term (Zoure and Genovese, 2023). Nevertheless, efforts to adapt sustainability principles in affordable housing projects through the adoption of modern construction methods, such as innovative prefabrication techniques, have been observed. Moghadi et al. (2021) defined Sustainable Innovative Affordable Housing (SIAH) as the integration of innovative methods, practices, materials, and technologies in sustainable and affordable housing development.

Sustainable housing, as used in this paper, aligns with the holistic definition provided by the United Nations and the Brundtland Commission. The Brundtland Commission's definition of sustainability emphasizes meeting present needs without compromising the ability of future generations to meet their own. Therefore, sustainable housing encompasses three main dimensions: environmental, social, and economic sustainability (Gbadegesin and Marais, 2020). This paper adopts this comprehensive approach by considering how various housing strategies contribute to sustainability in these dimensions. Environmental sustainability in housing focuses on minimizing ecological footprints through the use of eco-friendly materials, energy-efficient technologies, and sustainable construction practices. For instance, 3D-printed homes use materials

like recycled plastics and minimize waste through precise construction processes (Rekhi and Stern, 2022). Upcycling, another innovative approach, involves reusing waste materials to create building components, thereby reducing landfill waste and resource consumption (Akinlolu et al., 2022). Green building practices also fall under this category, emphasizing the use of renewable energy sources, natural ventilation, and sustainable building materials (Zoure and Genovese, 2023).

Social sustainability in housing addresses the need for inclusive, equitable, and community-centered living environments. This dimension ensures that housing solutions promote social cohesion, community involvement, and access to essential services. Co-housing and community-based housing models are prominent examples of socially sustainable housing strategies. These models enhance a sense of community, reduce social isolation, and encourage collaboration among residents (Wakely and Riley, 2011). Inclusive housing policies, which mandate a percentage of affordable housing within new developments, also enhance social sustainability by promoting diverse and inclusive communities.

Economic sustainability in housing involves providing affordable housing solutions that are financially viable in the long term. This includes reducing construction and maintenance costs, ensuring energy efficiency to lower water and electricity bills, and supporting economic opportunities for residents. Incremental housing, where homes are gradually constructed as financial resources become available, demonstrates economic sustainability by allowing low-income families to improve their housing conditions over time (Wakely and Riley, 2011). Similarly, 3D printing can significantly reduce construction costs and time, making housing more affordable for low-income families.

- **Housing Affordability and Sustainability**

Based on the conditions of global economies recovering from pandemic lockdowns, the motivation to respond to climate change and the need for affordable and sustainable housing has not been widespread. Human factors, environmental disasters such as floods, population growth, and political unrest have increased the demand for housing. In addition to the factors mentioned here, safety has been a particularly challenging issue in Sistan and Baluchestan. With housing prices and mortgage rates being high, there is a significant need for affordable housing provision for low- to moderate-income households in South Africa. The objective of providing affordable housing is to break the cycle of poverty by enhancing people's access to job opportunities, as job security remains a pressing concern in communities worldwide (Ferlito et al., 2022).

Sustainability is understood as ensuring the social-political welfare of people and communities, providing sustainable economic applications, and protecting the environment from natural resource depletion.

Sustainability is regarded as one of the critical aspects of development in South Africa. This emphasis on sustainability was officially established in government publications regarding national climate change (2010), which specify the country’s strategy for responding to climate change (Du Plessis, 2007). Despite this declaration, the implementation of sustainable construction principles in the built environment has not progressed widely. This lack of sustainable construction principles in practice is largely attributed to cost-based shortcomings (Moghayedi et al., 2021).

The construction industry plays one of the most significant roles in climate change through developments that minimize natural land, resource use, and the production of construction waste that contributes to landfill. This underscores the urgent need to meet housing demand in the most sustainable way possible. This must be achieved without compromising the quality, output rates, and costs of each project. To date, the focus on developing the housing sector has been significantly economic in nature. This aligns with the corresponding lack of dynamic elements embedded in sustainability. The absence of sustainable systems in construction, particularly concerning social, environmental, and innovative components, is a growing concern (Moghayedi et al., 2020).

- **Environmental Sustainability in Housing**

Moghimi and colleagues explain that sustainable housing refers to the use of sustainable construction methods, technologies, and building components, as well as promoting greener principles for sustainable living. Since the 1990s, there has been a global consensus that the construction and building industry impacts the natural environment in a highly unsustainable way. This is evident in the heavy use of natural resources by the construction and building industry, land clearing, and disruption of habitats, excessive consumption of energy and water, indiscriminate pollution of agricultural soils and natural waters, and the production of non-biodegradable waste that fills landfills.

The construction and building industry also contributes to the development of urban heat island effects through urban sprawl and hard surface coverage, which aids in global warming. Minimizing CO2 emissions, along with generating renewable energy and conserving water, with a focus on efficient use and conservative consumption of natural resources to cause minimal or no harm, are some of the environmentally sustainable

strategies used in housing to combat the negative impact of the construction industry on the environment.

- **Integration of Sustainable Housing Strategies**

A truly sustainable housing strategy for low-income families in Sistan and Baluchestan requires an integrated approach that addresses all three dimensions of sustainability. For example, mixed-use developments combine residential, commercial, and recreational spaces, promoting economic activity while reducing transportation needs. Incorporating green building practices into these developments can enhance their environmental sustainability by reducing energy consumption and carbon emissions (Friedman, 2023). Housing models and incremental housing can be integrated to provide social and economic benefits. By sharing resources such as kitchens and laundry facilities, residential communities can lower living costs and strengthen social interactions. At the same time, allowing residents to build and gradually upgrade their homes can make these communities financially accessible to low-income families (Jacobus, 2015).

Several studies have explored innovative strategies for sustainable housing for low-income populations, which are summarized below.

Heydari Chiyaneh and colleagues (2010) examined the role of urban development strategies in housing policies for low-income urban groups in Rasht. Their analysis shows that although the primary goal of these homes has been to provide housing for low-income urban groups, most residents belong to middle and upper-middle-income groups.

Ohdnezhadroshati and Moradimofrad (2013), in an article titled "The Role of Urban Development Strategy in Urban Income" (Case Study: Zeroabad and Bisim Regions of Zanjan City), found that in the core components of providing low-interest housing, there is a determining role in motivating the retrofitting of residences, with 3.751% significance. Additionally, the second component, reflecting the improvement of people's economic conditions and their income increase, had a significance of 3.614%, and the third component, referring to the type of materials used in construction, accounted for 2.263% significance of the observations.

2. Research Methodology

This study aims to identify appropriate housing indicators by reviewing prior research, similar samples, and expert opinions. It then explores the impact of innovations on the performance and affordability of housing. Various methods have been employed to achieve the research results: the information gathering method includes both bibliographic and field research. The bibliographic method utilizes scientific sources, computer disks, personal and private documents, press articles, journals, and relevant books on the housing of low-income groups.

3.1 Indicators

The discussion of appropriate housing indicators has long occupied the minds of specialists. It can boldly be said that these indicators are the most crucial tools in housing planning. Among these indicators, the qualitative aspects of housing have garnered significant attention, making it essential to address this matter. Adequate housing is recognized as part of the right to improve living conditions in international documents, including the Universal Declaration of Human Rights (1984) and the International Covenant on Economic, Social, and Cultural Rights (1966). Adequate housing involves more than just a roof and four walls; certain conditions must be met for specific forms of accommodation to be considered adequate. These elements are presented in Table 1:

Table 1: Indicators of Adequate Housing

Property Security	Adequate housing provides residents with a degree of property security that ensures legal protection against forced eviction, harassment, and threats.
Access to Services, Materials, Facilities, and Infrastructure	Adequate housing ensures residents have access to safe drinking water, adequate sanitation, energy for cooking, heating, lighting, food storage, and accessible services and infrastructures.
Affordability	Adequate housing holds value for residents, considering their rights as part of other human rights.
Habitability	Adequate housing guarantees physical health or provides suitable space and protection against cold, dampness, heat, rain, wind, and other health threats and structural hazards.
Accessibility	Adequate housing takes into account the specific needs of marginalized and disadvantaged groups.
Location	Adequate housing is located near job opportunities, healthcare services, schools, and centers.

3.2 Innovative Sustainable Affordable Housing Strategies (SIAH) for Low-Income Families

This section presents various innovative strategies to address housing issues for low-income families. These include mixed-use developments, incremental housing, low-rent housing, inclusive housing, 3D printing, high-cycle housing, micro-housing, community-led housing, co-housing, and green building practices (Table 2). While the presentation encompasses a combination of strategies, methods, tools, and practices, it is essential to note that these categories are not precisely defined in this paper. For example, while 3D printing can be classified as a tool/method, green building is classified as a practice. However, this paper collectively refers to all these under "strategies/approaches," as the goal is not to delve deeply into clear classifications.

Furthermore, it is important to recognize that some strategies may show similarities, albeit under different names in various fields or countries. This means that these approaches/strategies are not mutually exclusive and can often overlap or be integrated. This paper also discusses how these approaches can be used together to comprehensively address housing challenges. Future research may be able to categorize these strategies based on their nature and purpose (strategy, method/tool, practice, etc.) and provide a clearer framework for understanding and implementation.

Table 2: Innovative Sustainable Affordable Housing Strategies (SIAH) for Low-Income Families

Approaches	Objective	Benefits	
Mixed-Use Developments	The objective of mixed-use development is to create a more sustainable and livable urban environment by reducing the need for long commutes and promoting walkable neighborhoods.	Mixed-use development can provide multiple benefits for low-income families, such as better access to amenities by integrating commercial and institutional uses within residential areas. It can improve residents' access to essential facilities like healthcare, education, and retail services.	
Incremental Housing	| Incremental housing is an approach to housing development that involves building homes in stages over time rather than all at once (Kichanova, 2019). This approach allows residents to start with a basic structure and gradually add to it based on their needs and resources.	Incremental housing also allows residents to adapt their homes to changing needs and conditions over time.	
Low-Rent Housing	Low-rent housing is a housing development approach that provides affordable rental units for low-income families in urban areas (Millstein, 2020). This strategy has increasingly been used to promote sustainable housing solutions for low-income families by providing affordable housing options for those who may not be able to purchase homes at market rates.	Low-rent housing offers sustainable housing options for low-income families at risk of homelessness or housing insecurity (Matamanda et al., 2024).	

Micro-Housing	Micro-housing is a strategy for sustainable housing solutions that prioritizes efficiency and affordability in housing for low-income urban residents (Kichanova, 2019).	Small homes are designed to maximize the use of limited space, often through the use of multifunctional furniture, foldable and expandable features, and vertical space (Kichanova, 2019).	
Co-Housing	Co-housing involves multiple families living together in a shared space, each with their own private living quarters (Wang et al., 2020). Residential communities often share resources such as kitchens, gardens, and laundry facilities, which can help reduce the overall environmental impacts of the community.	This type of living arrangement can enhance social cohesion and reduce feelings of isolation experienced by many low-income urban residents.	
Green Building	Sustainable building practices, such as using eco-friendly materials, incorporating energy-efficient technologies, and maximizing natural light and ventilation, can help reduce the environmental impacts of housing projects (Zoure and Genovese, 2023).	Green building practices represent a range of sustainable construction methods that can reduce the environmental impacts of housing development while enhancing the health and well-being of residents (Karimi et al., 2023). Green building practices can be particularly beneficial for low-income families, who often face challenges related to inadequate living conditions, limited access to essential services like clean water and sanitation, and exposure to environmental toxins.	

3. Conclusion

The need for affordable and sustainable housing is a global phenomenon. However, achieving affordability and sustainability as concepts in housing development has not always been easy. Integrating sustainability into affordable housing using innovative technologies serves as a conceptual framework aimed at meeting both criteria for affordability and sustainability. The findings of this study provide valuable insights into innovative strategies, best practices, and potential solutions for integrating sustainability and affordability in housing design in South Africa.

This paper informs policymakers, architects, developers, and other stakeholders in the housing sector, enabling them to make informed decisions and implement effective actions to address the urgent need for sustainable and affordable housing solutions across Africa and beyond. The article examines a wide range of innovative and sustainable housing strategies aimed at tackling the housing challenges faced by low-income families in Africa. Each strategy offers unique benefits and presents specific challenges, contributing valuable insights to the discourse on sustainable housing.

Through an analysis of upcycling, micro-housing, co-housing, and green building practices, this paper provides a comprehensive look at how these approaches can be implemented to create affordable and sustainable housing solutions. The strategies discussed in this paper are interconnected and can be combined to develop more holistic housing solutions. For example, mixed-use developments can incorporate green building practices to enhance sustainability, offering environmentally friendly and economically feasible housing options. Similarly, incremental housing can benefit from upcycled materials, reducing costs and

environmental impacts while allowing for gradual improvements to homes.

These interrelationships highlight the importance of a holistic approach to housing development, in which multiple strategies are employed together to address the diverse needs of low-income urban populations. By leveraging the strengths of each strategy, policymakers and developers can create more effective and sustainable housing solutions.

Over the past few decades, informal settlements have gradually formed and expanded, primarily on the outskirts of cities, outside the formal urban development plan, and in an uncontrolled manner. These informal or marginal settlements serve the primary function of providing land and construction patterns suitable for the financial capacity of low-income groups, often migrants. Such settlements, characterized by unattractive landscapes, inadequate services, vulnerable residents, and uncertain employment, create an environment conducive to social anomalies and the reproduction of poverty, and they are highly susceptible to natural disasters. This situation necessitates the development of a suitable framework and mechanisms, as well as defining how the public and private sectors can coordinate and engage community participation to address the issues of informal housing. Therefore, the author suggests that researchers, recognizing this pressing need—one of the significant challenges and issues of housing—should pursue studies and research aimed at organizing and empowering informal settlements.

Based on the findings of this article, several recommendations can be made:

- Policy Support: Governments should establish supportive regulatory frameworks to facilitate the adoption of innovative housing strategies, especially in urban areas.
- Public-Private Partnerships: Cooperation between the public and private sectors can provide the necessary financial and technical support for the widespread implementation of these strategies.
- Community Participation: Active involvement of communities in the planning and development process can enhance the acceptance and success of housing projects.
- Financial Incentives: Subsidies and financial assistance programs can help offset the higher initial costs of green building practices and other innovative construction methods.

References

1. Ahad Nejad Roshti, M., Moradi Mofrad, S. (2013). The role of urban development strategy in housing policies for low-income urban groups: A case study of Safarabad and Bisim areas of Zanjan City. Regional Planning Quarterly, Winter, 1-15.
2. Akinlolu, M., Haupt, T. C., Edwards, D. J. annd Simpeh, F. (2022). A bibliometric review of the status and emerging research trends in construction safety management technologies. International Journal of Construction Management.22(2022). 2699-2711.
3. Ali-Hosseini, M., Hosseini, S. B., & Nasibi, F. (2011). Examining sustainable development from economic and environmental perspectives with a focus on housing position: A case study of the old texture of Bushehr. Journal of Economics and Regional Development, 1, 152-165.
4. Collins, D., de Vos, E., Evans, J., Severson Mason, M., Anderson-Baron, J., Cruickshank, V. and McDowell, K. (2022). “When we do evict them, it’sa last resort”: Eviction prevention in social and affordable housing. Housing Policy Debate.32(2022). 473-490.
5. Ferlito, T. L., Musonda, I., Tjebane, M. M. and Onososen, A. (2022). Systematic literature review on sustainable construction strategies for the development of affordable housing. In Proceedings of the Twelfth International Conference on Construction in the 21st Century (CITC-12 Amman, Jordan) . pp. 195-203).
6. Friedman, A. (2023). Energy efficient dwellings. In: Fundamentals of innovative sustainable homes design and construction. Cham: Springer; p. 229–60.
7. Gbadegesin, J. and Marais, L. (2020). The state of housing policy research in Africa. International Journal of Housing Policy. 20(2020).474-490.
8. Gbadegesin, J., Marais, L., Von Maltitz, M., Cloete, J., Lenka, M., Rani, K. and Pretorius, W. (2022). Student housing satisfaction at a South African university. Journal of Student Affairs Research and Practice. 59(2022). 559-579.
9. Golubchikov, O., & Badyina, A. (2012). Sustainable housing for sustainable cities: a policy framework for developing countries. Nairobi, Kenya: UN-HABITAT.

10. Haydari Chiane, R., Taba Azgami, R., & Khadijeh. (2010). The role of urban development strategy in housing policies for urban low-income groups: A case study of the City of Rasht. Journal of Urban Studies, 15, 45-60.
11. Jacobus, R. (2015). Inclusionary housing: Creating and maintaining equitable communities. Cambridge: Lincoln Institute of Land Policy.
12. Karimi, H., Adibhesami, M. A., Bazazzadeh, H. and Movafagh, S. (2023). Green buildings: Human-centered and energy efficiency optimization strategies. Energies. 16(2023). 3681.
13. Khan, S. A., Jassim, M., Ilcan, H., Sahin, O., Bayer, İ. R., Sahmaran, M. and Koc, M. (2023). 3D printing of circular materials: Comparative environmental analysis of materials and construction techniques. Case Studies in Construction Materials, 18, e02059.
14. Kichanova, V. (2019).Size doesn't matter: Giving a green light to micro-homes. Adam Smith Institute.
15. Matamanda, A. R., Mafuku, S. H., & Bhanye, J. I. (2024). The potential of Chinhoyi as a fast-growing secondary city in addressing urban challenges in Zimbabwe. Journal of Asian and African Studies. 59(2024). 1408-1425.
16. Mete, S. and Xue, J. (2020). Integrating environmental sustainability and social justice in housing development: two contrasting scenarios, Progress in Planning. 135 (2020). 1-16.
17. Millstein, M. (2020). If I had my house, I'd feel free': housing and the (re) productions of citizenship in Cape Town, South Africa. In Urban Forum (Vol. 31, No. 3, pp. 289-309). Dordrecht: Springer Netherlands.
18. Rekhi, J. and Stern, A. (2022). 3D Concrete Printed Construction. Cityscape. 24(2022). 221-230.
19. Rekhi, J., & Stern, A. (2022). 3D Concrete Printed Construction. Cityscape. 24(2020). 221-230.
20. Tupenaite, L., Lill, I., Geipele, I. and Naimaviciene, J. (2017). Ranking of Sustainability Indicators for Assessment of the New Housing Development Projects: Case of the Baltic States, Journal of Resources. 6 (2017).55- 71.
21. Wakely, P. and Riley, E. (2011) The case for incremental housing. Cities Alliance.
22. Wakely, P. and Riley, E. (2011). The case for Incremental Housing, Cities Alliance Policy Research and Working Papers Series No. 1. Cities Alliance, Washington, DC.
23. Wang, J., Hadjri, K., Bennett, S. and Morris, D. (2020). The role of cohousing in social communication and sustainable living environments. WIT Transactions on the Built Environment, 193(2020). 247-258.
24. Yip, N.M., Mohamad, J. and Ching, G,H, (2017), Indicators of Sustainable Housing Development (SHD): A Review and Conceptual Framework, International Journal of Scientific & Engineering Research . 8 (2017). 1- 9.
25. Zoure, A. N. and Genovese, P. V. (2023). Implementing natural ventilation and daylighting strategies for thermal comfort and energy efficiency in office buildings in Burkina Faso. Energy Reports. 9(2023). 3319-3342.
26. Zoure, A. N., & Genovese, P. V. (2023). Implementing natural ventilation and daylighting strategies for thermal comfort and energy efficiency in office buildings in Burkina Faso. Energy Reports. 9(2023). 3319-3342.