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EDITED AND REVIEWED BY
Hazim Bashir Awbi,
University of Reading, United Kingdom

*CORRESPONDENCE
Karoline Figueiredo,
✉ karolinefigueiredo@poli.ufrj.br

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Editorial: Global excellence in indoor environment: South America

Karoline Figueiredo^{1*}, Grace Tibério Cardoso² and
Mohammad K. Najjar¹

¹Programa de Engenharia Ambiental (PEA), Federal University of Rio de Janeiro, Rio de Janeiro, Brazil,
²Postgraduation Program of Architecture and Urbanism, School of Engineering and Applied Sciences,
Atitus Educação Campus Santa Teresinha, Passo Fundo, Brazil

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Editorial on the Research Topic

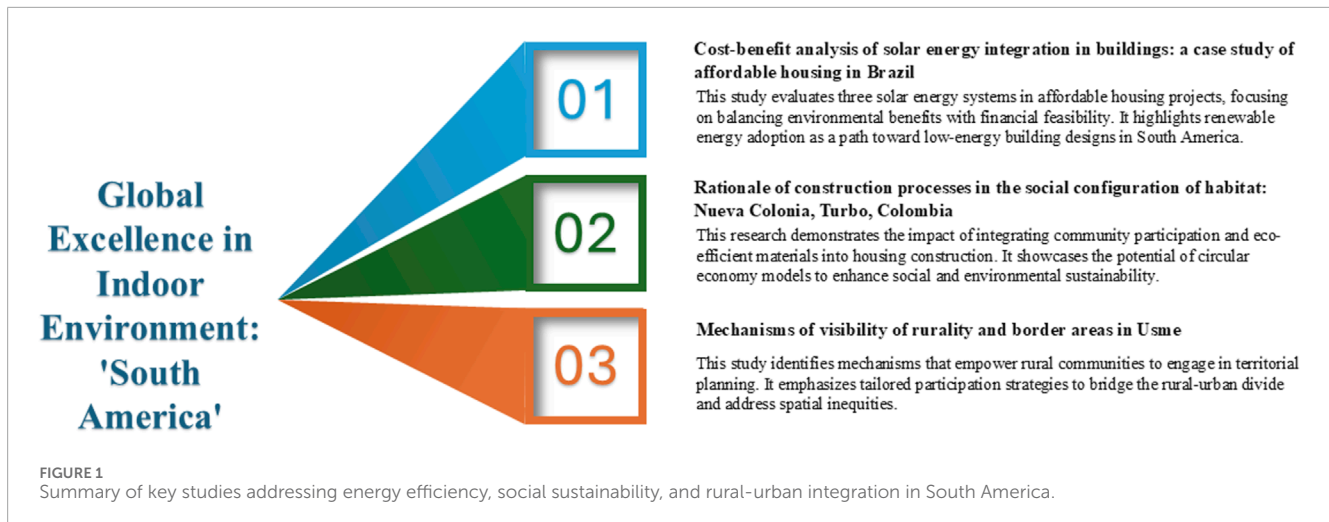
Global excellence in indoor environment: South America

Indoor environmental quality is a multidisciplinary field that intersects architecture, engineering, environmental science, and urban planning, focusing on creating spaces that are energy-efficient, sustainable, and promote human wellbeing. Studies highlight that unsatisfactory thermal environments in indoor spaces can compromise health and hinder productivity, particularly for individuals spending extended hours indoors (Kong et al., 2022). Therefore, innovative air distribution methods, such as sidewall air supply and interactive cascade ventilation, have demonstrated significant potential for improving thermal comfort while optimizing energy use (Yang et al., 2024; Tian et al., 2021).

In the Global South, the significance of this field is amplified by the dual pressures of rapid urbanization and socioeconomic disparities (Aguilar and Hernandez-Lozano, 2024). More specifically, South America is uniquely characterized by diverse climates, abundant natural resources, and dynamic socio-political scenarios. These challenges and opportunities require advancing innovative solutions tailored to regional needs. Therefore, indoor environmental research in South America must address a wide range of issues, from improving energy efficiency in affordable housing to enhancing thermal comfort in densely populated urban areas. The region's diversity in climate zones demands localized approaches that balance environmental sustainability with economic feasibility.

In this vein, this Research Topic, "Global Excellence in Indoor Environment: South America," presents three studies that address critical challenges in energy efficiency, social sustainability, and rural-urban integration. Together, they underscore South America's pivotal role in advancing research on low-energy building designs, renewable energy systems, and participatory planning, offering both localized insights and global implications. Thus, this Research Topic reflects an urgent need to develop adaptable and inclusive approaches to improving indoor environmental quality in South America.

The first article, De Arruda et al. comprehensively evaluates three solar energy systems implemented in a government-subsidized housing program aimed at providing affordable homes for low-income families. The study's comparative analysis reveals the trade-offs between environmental benefits and economic feasibility. The zero-energy



balance photovoltaic system outperformed energy savings and carbon emission reductions, achieving a significant reduction in operational energy use. However, the solar heating system demonstrated superior financial viability with a shorter payback period, making it more practical for widespread adoption in affordable housing.

This research highlights the importance of model-based decision-making in optimizing energy solutions for resource-constrained settings. By leveraging simulations and cost analyses, the study bridges the gap between ambitious sustainability goals and realistic implementation strategies. It also emphasizes South America's vast solar potential, positioning renewable energy systems as integral to achieving low-energy building designs and mitigating climate change in the region.

The second article, [Cuervo Calle et al.](#) discusses the socio-environmental dynamics of sustainable housing. Utilizing participatory design methods, this study engages local communities in developing eco-efficient construction technologies. By incorporating banana industry waste into building materials, the research demonstrates a circular economy model that reduces costs, minimizes environmental impacts, and fosters local economic resilience.

The paper also examines the integration of vernacular knowledge and modern construction techniques, creating context-sensitive solutions that respect cultural and environmental specificities. This approach not only enhances the quality of social housing but also strengthens community ownership and long-term sustainability. The study's alignment with the sustainable development goals (SDGs), particularly SDG 11 on sustainable cities and communities, emphasizes the role of inclusive design processes in achieving sustainable urban and rural development, particularly in regions experiencing rapid infrastructural transitions.

Finally, the third article, [Meneses-Baez et al.](#) shifts the focus to the often-overlooked rural-urban interface. Using a mixed-methods approach, the study identifies visibility mechanisms that empower rural communities in Bogotá's Usme locality to participate in territorial planning. The authors develop a framework comprising five dimensions: spaces of visibility, forms of participation, places of participation, dimensions of rurality, and types of impact. This framework addresses systemic inequalities in territorial management

by promoting community agency and co-responsibility among government, civil society, and rural inhabitants. The study's findings highlight the need for differentiated strategies that account for varying socio-spatial dynamics within rural-urban borders. By fostering inclusive participation, this research bridges the divide between rural and urban agendas, ensuring that infrastructural planning meets the needs of marginalized communities. The three papers are summarized in [Figure 1](#).

A central theme emerging from these studies is the pivotal role of context in determining the success of sustainability initiatives. Each study exemplifies how localized solutions, grounded in understanding specific socio-economic, cultural, and environmental conditions, can drive meaningful progress. Despite their distinct focuses, these studies share an interdisciplinary approach integrating technological innovation, social engagement, and spatial analysis. The Brazilian research provides a scalable model for incorporating renewable energy systems into affordable housing, addressing both environmental and economic challenges. The Colombian study on Nueva Colonia underscores the transformative impact of community-driven design, showcasing how participatory approaches can align construction practices with local needs and resources. Similarly, the Usme case study highlights the significance of visibility and tailored participation mechanisms in bridging rural-urban divides and tackling spatial inequities. Together, these studies demonstrate that successful sustainability efforts must be both innovative and deeply contextual, blending technical solutions with human-centered approaches.

Building on these findings, future research efforts could discuss integrating emerging technologies, particularly digital twins and artificial intelligence (AI), to significantly enhance energy efficiency and facilitate participatory planning processes. Digital twins, which create virtual replicas of physical systems, could enable a more nuanced understanding of energy consumption patterns and resource allocation ([Figueiredo et al., 2024](#)), while AI could analyze vast datasets to optimize energy use and predict future trends ([Chou and Nguyen, 2024](#)). Additionally, conducting comparative studies across various regions of the Global South could provide invaluable insights into how tailored, localized solutions can effectively inform and shape global

practices. By examining these regions' unique socio-economic and environmental contexts, researchers can uncover innovative strategies that address energy challenges and foster sustainability.

Ultimately, encouraging cross-border collaborations within South America could leverage diverse expertise and resources and amplify the region's contributions to tackling pressing global challenges. By establishing frameworks for cooperative initiatives, South American countries can exchange knowledge and best practices, thus improving their collective ability to tackle global issues such as climate change, energy poverty, and environmental degradation.

Author contributions

KF: Funding acquisition, Project administration, Supervision, Visualization, Writing—original draft, Writing—review and editing. GT: Visualization, Writing—review and editing. MN: Visualization, Writing—review and editing.

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Conflict of interest

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Generative AI statement

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