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Mapping the field of sustainable slum upgrading: A comprehensive bibliometric analysis of global practices

Edi Rusdiyanto [1], Eka Pariyanti [1*]

[1] Universitas Terbuka, Banten, INDONESIA
***Corresponding Author:** eka.pariyanti@ecampus.ut.ac.id

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ABSTRACT

This study analyzes global research trends and citation structures in the field of slum upgrading, identifies key contributors, evaluates global strategies and their implementation, and examines their alignment with the sustainable development goals (SDGs). Using a bibliometric approach, this study analyzes 327 articles published between 2015 and 2024 through co-citation analysis, keyword co-occurrence analysis, and network visualization to identify major research clusters. The findings reveal key trends, influential contributors, and significant research directions in this area. Effective strategies include policy interventions, community participation, infrastructure improvements, and technological innovations. Aligning these strategies with SDG 11 is essential to support sustainable urban development. The originality of this research lies in its comprehensive bibliometric analysis, mapping of research gaps, and its contribution to evidence-based policymaking and stakeholder collaboration. This study emphasizes the importance of aligning slum upgrading strategies with SDG 11 in order to achieve sustainable, inclusive, and resilient urban development. Understanding research trends allows stakeholders to access influential studies and implement evidence-based policies. Furthermore, the study highlights various adaptive strategies that can be applied in different contexts of slum upgrading.

Keywords: sustainable development goals, slum upgrading, slum redevelopment, slum improvement, SDGs, sustainable urban development

INTRODUCTION

The United Nations has launched an extensive and diverse Slums remain a pressing global issue, with more than 1 billion people living in informal settlements worldwide (Azunre et al., 2025). These areas are characterized by poor infrastructure, inadequate sanitation, high population density, and vulnerability to climate change (Damte et al., 2023). Rapid urbanization in developing countries has further reinforced the need for sustainable solutions to improve slum conditions. These settlements are often inhabited by low-income communities that face limited access to essential services such as clean water, electricity, and sanitation (Abdulhadi et al., 2024; Akpabio et al., 2021). Additionally, many slums develop in disaster-prone areas, such as coastal regions or steep slopes, which further heightens the risks for residents.

The growth of slums is primarily driven by socio-economic factors, including poverty, unemployment, and a lack of affordable housing (Kajiita & Kang'ethe, 2024). As cities expand rapidly without adequate planning, many low-income residents are forced to settle in informal areas that often lack legal recognition and social protection (Baqai & Ward, 2020; Tacoli, 2017). As a result, they become vulnerable to various challenges, ranging from crime and disease outbreaks to natural disasters. However, slums also serve as hubs for informal economies and strong social networks (Alaazi & Aganah, 2020). Addressing this issue therefore requires a comprehensive approach aimed at improving the well-being of their residents.

Various countries have implemented slum upgrading programs to enhance living conditions through infrastructure development, community participation, and land tenure security (Rao P et al., 2022; Rigon, 2022). Key interventions include the provision of clean water, sanitation, waste management, electricity, drainage, roads, and public lighting (Adama, 2020). These improvements are crucial for health and quality of life. A road-based approach, as seen in Rio de Janeiro and São Paulo, focuses on settlement restructuring and better connectivity (Acioly, 2021). Community participation is also vital to ensure that interventions reflect residents' actual needs (Terdoo, 2024). Programs such as KOTAKU in Surabaya demonstrate the importance of community involvement in decision-making and implementation (Roitman, 2019). Furthermore, land tenure security enhances legal protection and reduces the risk of eviction (Abdillah et al., 2022), while

socially inclusive strategies help prevent the marginalization of vulnerable groups, including women, children, and persons with disabilities (Yeboah et al., 2021).

Slum upgrading aligns with multiple sustainable development goals (SDGs), particularly SDG 11 (sustainable cities and communities), which promotes inclusive, safe, resilient, and sustainable cities. It also contributes to SDG 1 (no poverty), SDG 3 (good health and well-being), SDG 6 (clean water and sanitation), SDG 7 (affordable and clean energy), SDG 8 (decent work and economic growth), and SDG 10 (reduced inequalities).

Despite its importance, slum upgrading faces significant challenges, including financial constraints, social disruptions, and varied socio-economic impacts (Cherunya et al., 2021). Implementation must consider affordability and potential effects on livelihoods (Soma et al., 2022). Construction activities can disrupt community life, requiring careful planning (Yeboah et al., 2021). While infrastructure improvements can reduce disease incidence, their influence on income levels is less certain. Slum upgrading also plays a role in SDG 13 (climate action) by enhancing urban resilience and implementing adaptation strategies through infrastructure improvements and disaster risk reduction policies.

Innovative approaches such as ecotourism in coastal slums, supported by infrastructure investments, can contribute to poverty reduction and sustainable development (Surya et al., 2021). Furthermore, leveraging technology such as digital mapping and spatial analysis can improve planning and execution (Mahabir et al., 2020).

Given the complexity of challenges in slum settlements, upgrading efforts have become a vital strategy for promoting sustainable urban development (Denaldi & Cardoso, 2021). This study conducts a comprehensive bibliometric analysis to map global research trends, identify key contributors, and uncover gaps in the literature related to slum upgrading. It also aims to provide insights into policy directions and practical applications for future implementation. A multidisciplinary approach is essential to ensure that slum upgrading is effective and sustainable, considering technical, social, economic, and environmental dimensions.

To achieve these objectives, the study addresses the following research questions:

1. What are the global research trends and citation structures in the slum upgrading research corpus?
2. Who are the most active contributors in this field?
3. What are the global slum upgrading strategies and their implementations?
4. How does slum upgrading relate to the achievement of the SDGs?
5. What are the significant themes and potential research avenues in slum upgrading?

By answering these questions, this study aims to advance understanding of global slum upgrading research and provide actionable recommendations for evidence-based policymaking and sustainable development planning. The findings are expected to serve as a foundation for researchers, practitioners, and policymakers in designing strategies that promote more inclusive, resilient, and livable urban environments.

METHODOLOGY

This study applies bibliometric analysis to examine the dynamics, trends, and research developments in slum upgrading. Bibliometric analysis is a widely used quantitative technique for evaluating scholarly literature, as it enables the identification of publication patterns, author collaborations, and research network structures within a specific domain.

Two main bibliometric approaches are employed: performance analysis and science mapping (Donthu et al., 2021). Performance analysis helps assess the productivity and impact of researchers, journals, and institutions, while science mapping reveals the structural and conceptual relationships across studies in the field.

The methodological framework draws on techniques established in recent bibliometric studies (Mikul & Mittal, 2023), including citation analysis, keyword co-occurrence analysis, and the exploration of inter-publication relationships. Furthermore, bibliometric laws such as Bradford's law and Lotka's law are applied to identify core journal clusters, patterns of scientific productivity, and the distribution of literature contributing to the development of this research field (Bagdi & Nimbrain, 2025).

For data visualization and analysis, we used VOSviewer, a tool designed to construct and visualize bibliometric networks such as co-authorship, co-citation, and keyword co-occurrence networks. This tool facilitates the identification of thematic clusters and collaboration patterns among researchers and institutions.

We selected the Scopus database for this review due to its comprehensive journal coverage, higher source reliability, and broader indexing compared to other databases (Paul et al., 2021). A systematic and replicable search strategy was designed using well-defined and relevant search terms, incorporating Boolean operators and keyword variations. Following best practices in bibliometric research (Khatib et al., 2023), we used search terms such as "slum upgrading," "slum redevelopment," and "slum improvement."

The literature search was conducted on March 1, 2025, targeting articles published between 2015 and 2024, to capture research developments over the past decade. The search was restricted to titles, abstracts, and keywords to ensure precision and relevance, initially yielding 385 documents.

To refine the dataset, we applied a rigorous screening process. In the first stage, titles and abstracts were reviewed to exclude studies unrelated to slum upgrading in the context of urban development and planning. The second stage involved full-text reviews to eliminate articles lacking empirical data or relevant policy/developmental perspectives. As a result, 38 documents were excluded, resulting in a final dataset of 327 publications that met all inclusion criteria.

To further broaden research coverage and enhance insight into both conceptual and practical dimensions, we incorporated additional search terms such as "slum upgrading

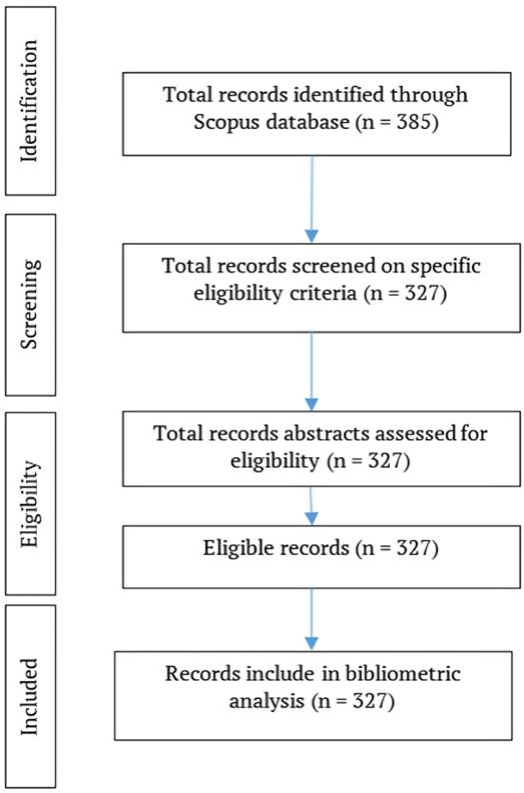

Figure 1. Bibliometric data selection flow (Source: Authors' own elaboration)

programs," "informal settlement redevelopment," and "urban slum improvement."

The final bibliometric analysis considered several key variables, including publication year, journal source, institutional affiliation, country of origin, and citation frequency. Multiple bibliometric indicators were applied to reveal publication trends, geographical distribution, and patterns of scholarly collaboration. These findings contribute to mapping the evolution and future trajectory of research in slum upgrading. To illustrate the scope of the meta-analysis, a visual representation is provided in **Figure 1**.

In summary, the bibliometric methodology applied in this study provides a structured and replicable approach for evaluating the state of research on slum upgrading. By employing established bibliometric techniques, leveraging bibliometric laws, and using visualization tools such as VOSviewer, this study ensures a comprehensive examination of scholarly output in the field. The multi-stage screening and keyword-based search strategy further enhance the accuracy and relevance of the final dataset. The insights derived from this analysis form the foundation for identifying major research themes, influential contributors, and future directions in slum upgrading studies, which will be explored in the subsequent sections.

RESULTS AND DISCUSSION

After carefully reviewing the selected articles through the outlined procedure, the next step involves conducting a detailed analysis. This analytical process uncovers a variety of insights that emerge through the synthesis of the research. In the following sections, a comprehensive breakdown of the findings is presented, carefully organized according to the three core research questions that guided this study. Each of these questions provides a clear framework for interpreting the results, ensuring that the analysis is both structured and relevant to the objectives of the research. The outcomes offer valuable perspectives that contribute to a deeper understanding of the topic under investigation.

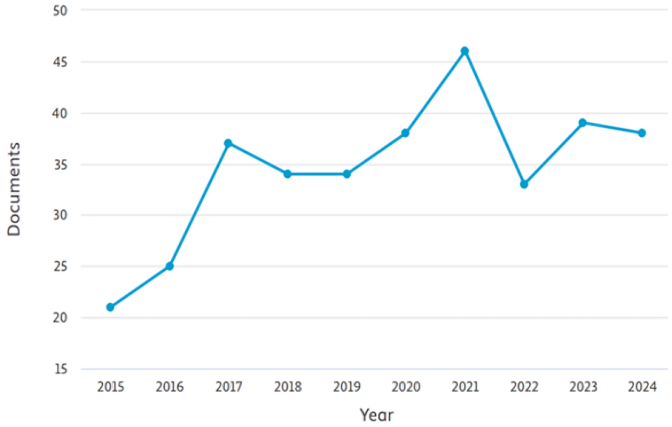

Figure 2. The research trend on slum upgrading (Source: Authors' own elaboration)

Global Research Trends and Citation Structures in the Slum Upgrading Research Corpus?

The research trend on slum upgrading shows increasing attention over time, albeit with some fluctuations (**Figure 2**). In 2015, the number of publications was still low, but began to increase in 2016 and 2017. A significant spike occurred in 2020, despite the world facing the COVID-19 pandemic, indicating that slums remain an important focus in urban development. 2021 recorded the highest number of publications, reflecting the increasing attention to sustainable development and social inclusiveness. Despite a slight decrease in 2022 and 2023, slum upgrading remains a relevant topic in global research. In 2024, the number of publications stabilized again, confirming that slum upgrading remains an integral part of global efforts to improve the quality of life in urban areas. Overall, despite year-to-year variations, these data indicate that the issue of slum upgrading remains relevant and an integral part of global efforts to address slum housing issues and improve the quality of life in urban areas.

Documents per year by source

The data in **Table 1** highlights the 15 leading publication sources in slum upgrading research, with Habitat International ranking highest (18 documents), reaffirming its focus on housing and urban development. The IOP Conference Series: Earth and Environmental Science (15 documents) underscores the significance of scientific conferences in discussions on environmental and urban issues. Journals such as Advances in 21st Century Human Settlements, Cities, Environment and Urbanization, and the International Journal of Urban Sustainable Development (8 documents each) establish a strong link between slum upgrading and sustainability. Other sources, including Sustainability and the Urban Book Series (7 documents each), further reinforce environmental and urban perspectives.

Table 1. Slum upgrading research per year by source

No	Source	D
1	Habitat International	18
2	IOP Conference Series Earth and Environmental Science	15
3	Advances in 21st Century Human Settlements	8
4	Cities	8
5	Environment and Urbanization	8
6	International Journal of Urban Sustainable Development	8
7	Sustainability	7
8	Urban Book Series	7
9	Urban Studies	5
10	International Journal of Disaster Risk Reduction	4
11	International Journal of Environmental Research And Public Health	4
12	Journal of Urban Economics	4
13	Buildings	3
14	Environment and Planning A	3
15	Environment Development and Sustainability	3

Note. D: Number of documents

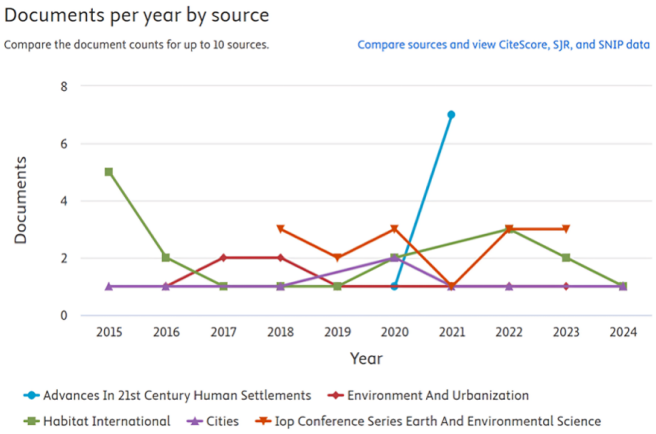

Figure 3. Slum upgrading research per year by source (Source: Authors' own elaboration)

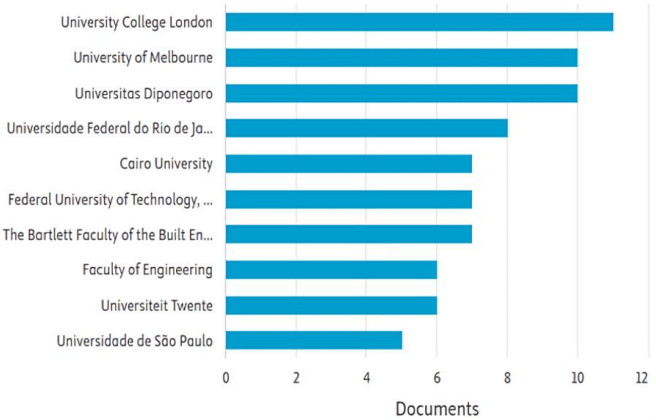

Figure 4. Slum upgrading by affiliation (Source: Authors' own elaboration)

Additionally, journals such as Urban Studies (5 documents), the International Journal of Disaster Risk Reduction, International Journal of Environmental Research and Public Health, and the Journal of Urban Economics (4 documents each) reflect the economic, health, and risk mitigation dimensions of slum upgrading research.

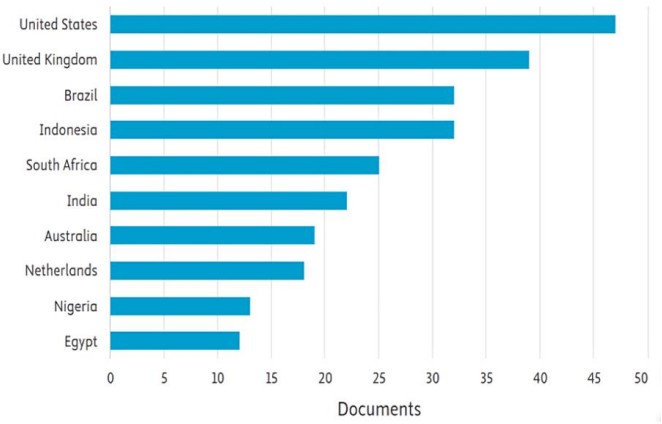

Figure 5. Slum upgrading by country (Source: Authors' own elaboration)

Overall, the data on documents per year by source can be seen in **Figure 3**. This list reflects the key academic platforms that support multidisciplinary studies on slum upgrading at a global level.

Documents by affiliation

We compare the document counts for up to 10 affiliations. The top 10 affiliations have made significant contributions to research on slum upgrading. University College London recorded the highest number of publications, with 11 documents, followed by the University of Melbourne and Universitas Diponegoro, each with 10 documents. This indicates that these institutions play a crucial role in advancing knowledge related to slum upgrading. Additionally, several universities from different parts of the world are actively involved in this research, such as Universidade Federal do Rio de Janeiro (8 documents), Cairo University, Federal University of Technology, Akure, and the Bartlett Faculty of the Built Environment (each with 7 documents). These affiliations reflect the geographical diversity and global engagement in addressing slum settlement issues. Although the publication counts from the next institutions Faculty of Engineering, Universiteit Twente, and Universidade de São Paulo are slightly lower, they still demonstrate significant contributions, with 6 and 5 documents, respectively.

Figure 4 reflects that leading universities from various countries pay great attention to this issue, striving to develop research-based solutions that can be implemented in different regions with varying slum settlement conditions.

Research by country

Research on slum upgrading is dominated by countries with the highest contributions, such as the United States, the United Kingdom, Brazil, and Indonesia (**Figure 5** and **Figure 6**). The United States leads with 47 documents, followed by the United Kingdom with 39 documents, reflecting the significant contributions of these two countries in research and solutions for slum upgrading. Brazil and Indonesia, each with 32 documents, highlight the crucial role of developing countries in addressing slum housing challenges within their social and economic contexts. These countries focus on issues related to rapid urbanization and poverty. Their contributions demonstrate that slum upgrading is a global concern, with

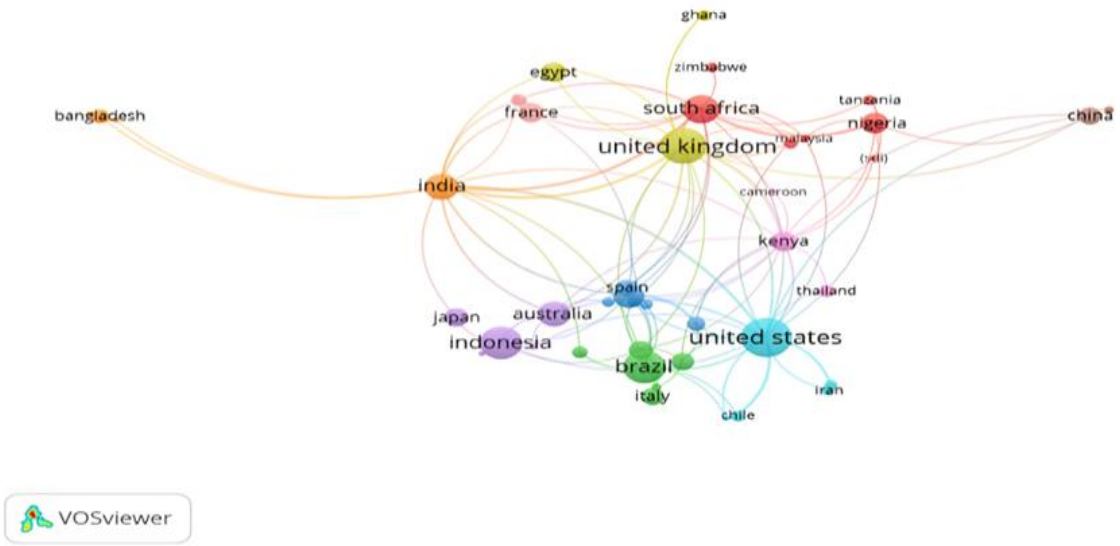

Figure 6. The research slum upgrading by country (Source: Authors' own elaboration)

Table 2. Compare the document counts for up to 10 author

No	Author	Documents
1	Adegun, O. B.	6
2	Shafique, T.	5
3	Dovey, K.	4
4	Galiani, S.	4
5	Sunarti, S.	4
6	Tadi, M.	4
7	Truffer, B.	4
8	Chatterjee, I.	3
9	Das, A.	3
10	Duangputtan, P.	3

both developed and developing nations actively seeking innovation- and sustainability-based solutions.

It is evident that countries actively engaged in slum upgrading research include the United States, the United Kingdom, Australia, Brazil, Indonesia, Egypt, Nigeria, the Netherlands, and several others. The United States contributes the most to this research, focusing on innovative solutions and sustainable housing policies in urban areas. The United Kingdom and Australia also play significant roles, emphasizing urban innovation and equitable access to adequate housing. Brazil contributes by highlighting social aspects and housing accessibility. Indonesia demonstrates its commitment to addressing urban slum issues with approaches tailored to its local context. Additionally, Egypt, Nigeria, and the Netherlands actively produce publications focusing on the challenges and solutions for slum housing in their urban regions.

The contributions of these countries reflect global attention to improving the quality of life in slum areas and the importance of international collaboration in addressing global housing challenges.

The Most Active Contributors in Research Slum Upgrading

The most active contributors in slum upgrading research are researchers who have published a significant number of works in this field, reflecting their involvement in examining slum settlement improvements from various perspectives.

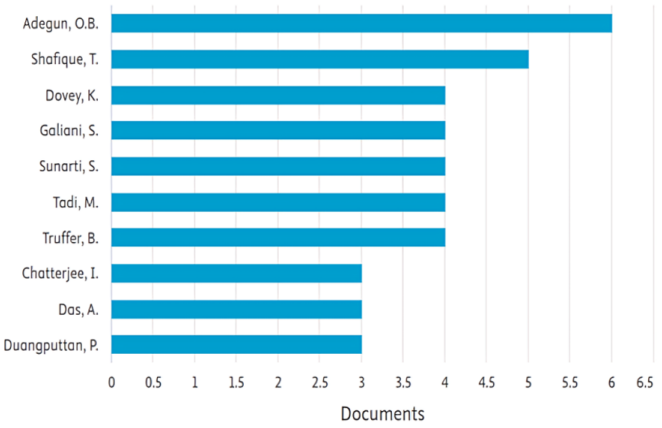

Figure 7. The document counts for up to 10 author (Source: Authors' own elaboration)

Table 2 presents an overview of the top 10 authors in slum upgrading research, comparing the number of documents each author has published. Adegun, O. B. emerges as the most prolific contributor with 6 documents, indicating a dominant role in the field and potentially reflecting a deep expertise in slum upgrading. Following Adegun, O. B., the authors Shafique, T., Dovey, K., Galiani, S., Sunarti, S., Tadi, M., and Truffer, B. each have 4 publications, positioning them as active researchers who are consistently contributing to the discourse on slum upgrading. These authors are likely involved in a range of collaborative efforts or focused on specific aspects of slum improvement. Meanwhile, Chatterjee, I., Das, A., and Duangputtan, P. have each published 3 documents, indicating their more specialized or emerging contributions to the field. Overall, the data highlights a concentration of scholarly output among a few key authors, suggesting that they play a crucial role in advancing research on slum upgrading. This concentration also points to potential opportunities for further collaboration, as the overall number of contributors remains relatively limited. The graph is given in **Figure 7**.

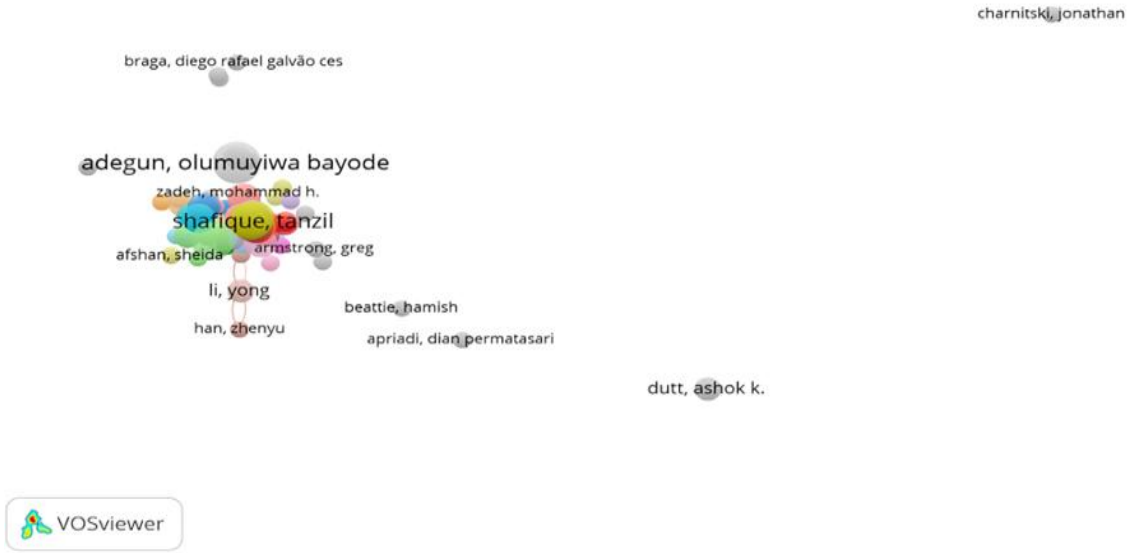

Figure 8. The document counts for up to 10 author (Source: Authors' own elaboration)

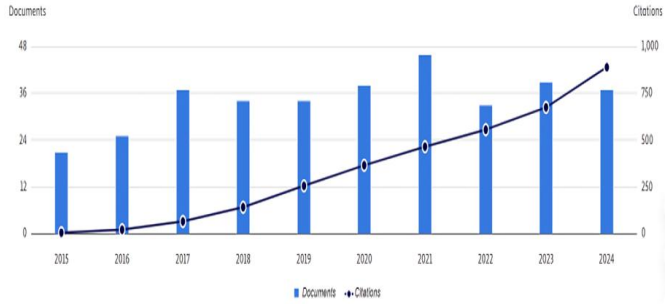

Figure 9. Citation structure (Source: Authors' own elaboration)

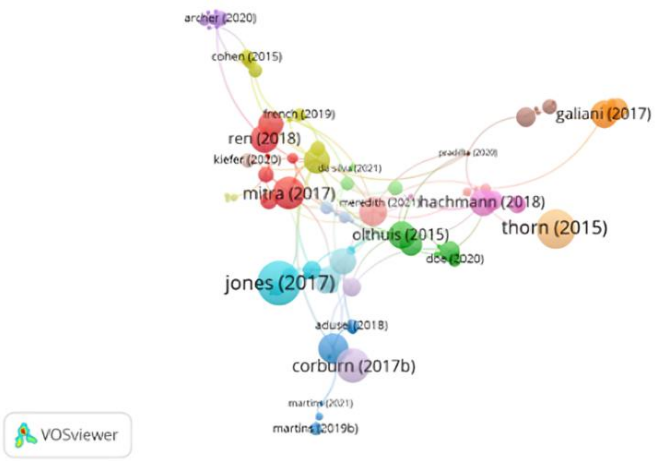

Figure 10. Slum upgrading quote structure (Source: Authors' own elaboration)

Overall, this list shows that slum upgrading research is developing through global collaboration with various scientific perspectives, reflecting the complexity and urgency of the slum settlement issue in different countries. **Figure 8** shows the results.

Authors with very large circles in bibliometric visualization represent those who have made significant contributions in publications or are frequently cited. Authors such as Adegun, O. B., with 6 documents, or other authors with similar numbers are clearly key figures in their research. Analyzing the distribution of these circle sizes helps to understand thought leadership, research trends, and author collaboration, which is highly useful for further research or for those interested in delving deeper into emerging topics. Thus, this visualization not only shows how often authors contribute to their field but also reflects how key ideas in a topic develop and connect between authors, providing broader insights for researchers and practitioners who want to understand the dynamics of current research.

Citation structure

The citation analysis of research on "slum upgrading" shows a significant upward trend year after year (**Figure 9**). Starting with only 5 citations in 2015, the number of citations has continued to rise exponentially, reaching 888 in 2024. The period of sharpest growth occurred between 2018 and 2019, when citations increased from 141 to 255, as well as between 2020 and 2021, with an increase from 365 to 464 citations. The average annual increase from 2015 to 2024 is around 88 citations per year, reflecting the growing relevance of this topic among researchers. Although the upward trend remains steady, the larger increase between 2023 and 2024 (214 citations) suggests that attention to slum upgrading research has been rising in recent years. This surge reflects the increasing importance of the slum upgrading topic in the context of urbanization, housing policies, and improving living conditions in slum areas. Among the studies with the most significant impact in the field of slum upgrading, three publications stand out with the highest number of citations as shown in **Figure 10**.

Several studies with the highest citation counts that have contributed to this field include the research by Thorn et al. (2015), which highlights how communities in Mathare Valley, Nairobi, have independently adapted to global environmental changes through innovation and revitalization. Meanwhile, the study by Persello and Stein (2017) developed an artificial intelligence (AI)-based method for detecting informal settlements using high-resolution satellite imagery, which has contributed to data-driven urban planning. Additionally, the

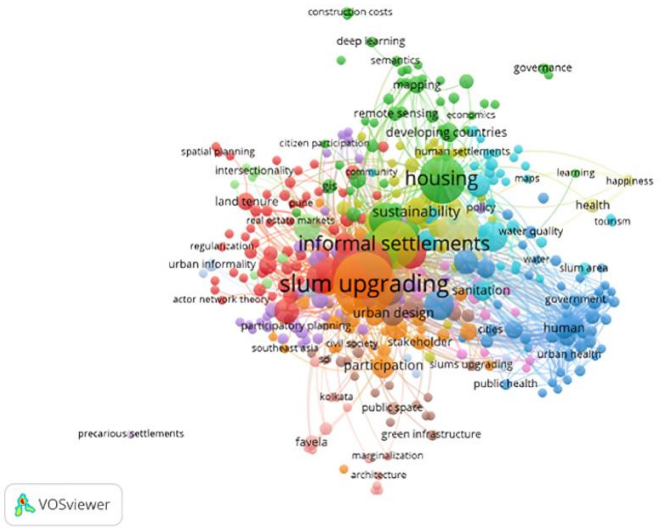

Figure 11. The analysis of keyword co-occurrence (Source: Authors' own elaboration)

research by Corburn and Sverdlik (2017) examines the relationship between slum upgrading and health equity, emphasizing how improvements in settlement conditions can impact the overall well-being of communities. These three studies play a crucial role in shaping academic discourse and policy related to slum improvement efforts across different parts of the world.

Keyword analysis

The analysis of keyword co-occurrence can enrich the content of each thematic cluster and indicate potential future directions within a specific field of study (**Figure 11**). The fundamental idea suggests that terms within the same cluster tend to share the same subject (Donthu et al., 2021). The node dimension represents the frequency of keyword occurrences, while the proximity between two terms is proportional to the edge width. The diversity of these themes highlights the necessity of a multidisciplinary and collaborative approach to achieving effective and sustainable solutions in slum upgrading.

The analysis of research on slum upgrading from 2015 to 2024 reveals the use of various keywords that reflect the complexity and multidisciplinary approach within this field. In addition to key terms such as "slum upgrading," "informal settlements," "housing," and "sustainability," other frequently emerging themes include governance and policy implementation, community participation and empowerment, as well as sustainability and environmental considerations. Research highlights the role of governance structures and the effectiveness of policy implementation in the success of slum upgrading initiatives (Denaldi & Cardoso, 2021). Active involvement and empowerment of local communities are considered crucial for the sustainability of these projects. Furthermore, environmental sustainability and resilience to climate change have become key focal points, particularly in addressing the impacts of climate change on housing in vulnerable communities (Khair et al., 2020). Housing quality and safety, along with the improvement of basic infrastructure such as roads, sanitation, and access to clean water, also remain primary concerns in slum upgrading projects.

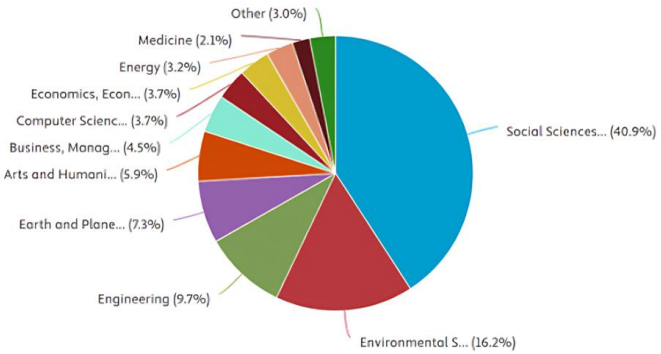

Figure 12. Subject area slum upgrading (Source: Authors' own elaboration)

Subject area

The analysis of subject area distribution in slum upgrading research reveals the involvement of various disciplines, with a primary focus on several key fields (**Figure 12**).

Research on slum upgrading is predominantly dominated by the field of social sciences, which accounts for 74.5% of total documents, reflecting a primary focus on social aspects, policies, and community involvement in slum improvement. Environmental science contributes 29.6%, highlighting significant attention to environmental management and sanitation. Engineering represents 17.7%, emphasizing technical and infrastructure aspects, while earth and planetary sciences account for 13.3%, indicating the importance of geological conditions and spatial planning. Other disciplines, such as arts and humanities (10.7%), business, management and accounting (8.1%), and computer science (6.7%), also make notable contributions, focusing on cultural, managerial, economic, and technological aspects. Additionally, economics, econometrics, and finance (6.7%) and energy (5.8%) provide perspectives on economic aspects and energy solutions. Fields such as medicine (3.8%), decision sciences (1.2%), and psychology (0.9%) also play a role, albeit smaller, underscoring the relevance of health, data-driven decision-making, and psychology in this context. While the majority of research focuses on social sciences and environmental studies, contributions from other disciplines remain crucial for a more holistic approach to slum improvement.

Research Based on Sponsor Funding

Funding sponsors play a crucial role in slum upgrading research, as they provide financial support for studies focused on sustainable infrastructure solutions and the development of inclusive policies (**Table 3**). Without this support, efforts to improve slum conditions would be significantly constrained. International sponsors enable the implementation of effective global solutions with widespread impact while also strengthening local capacities in managing slum improvement initiatives.

The total number of funded documents in slum upgrading research reaches 164, with the World Bank Group as the primary sponsor, followed by major institutions such as the Bill and Melinda Gates Foundation, the European Commission, and universities like Universitas Diponegoro and the University of Melbourne, each contributing four documents.

Table 3. The global slum upgrading strategy and its implementation

No	Collaboration strategy	Location & program examples	Results & benefits
1	Community-based approach	Know your city campaign (global), slum networking program, Hyderabad, India	Community-based mapping for inclusive urban planning, community-based WASH committees improve water, sanitation, and hygiene services
2	Government, private sector, and NGO collaboration	Dhaka, Bangladesh, Kibera, Nairobi	Public-private-NGO partnerships enhance water, sanitation, and infrastructure services, mobilization of resources for slum upgrading.
3	Participatory planning and settlement upgrading	Kitale, Kenya, slum networking project, Ahmedabad, India	Strengthens local capacity for settlement improvement and job creation, participatory-based settlement upgrading model accelerates project implementation
4	Community-based sanitation program	Mumbai, India, South Asia	Community toilet monitoring and maintenance systems strengthen relationships between communities and governments, encourages policies replicating successful community sanitation models
5	Informal settlement resilience building	Joint action for water, flood risk reduction, Cape Town, South Africa	Enhances community participation in urban planning and disaster mitigation, addresses flood risks through government, community, and civil organization collaboration
6	Urban greening initiative	Dhaka, Bangladesh	Greening projects engage communities to address governance gaps and increase citizen participation
7	Land tenure security (land tenure and legalization)	Favela Bairro, Brazil	Grants land certificates to residents to reduce eviction risks, legally integrates informal settlements into the city
8	Incremental housing & basic service provision	Sites and services project, Chennai, India	Provides land and basic services, allowing residents to build homes gradually
9	Digital technology for settlement upgrading	Slum dwellers international	Uses GIS, drones, and mobile applications for mapping and issue reporting, e-governance improves transparency and citizen engagement
10	Economic empowerment and employment	Dharavi, Mumbai	Skill training and entrepreneurship programs boost residents' economic potential, microcredit support for small businesses in informal settlements
11	Climate-resilient settlement upgrading	Jakarta, Indonesia	Green infrastructure and disaster-resistant housing designs mitigate climate change impacts
12	Transit-oriented development (TOD) for slum upgrading	Bogotá, Colombia, Jakarta, Indonesia	Integrates informal settlements with public transport to improve accessibility to jobs and services
13	Upcycling and local material utilization	Recife, Brazil	Uses recycled and locally sourced building materials to reduce costs and environmental impact
14	Social infrastructure development	Cape Town, South Africa	Develops schools, health centers, and community facilities in informal settlements to improve social well-being
15	Kota tanpa kumuh program	Various cities in Indonesia (Jakarta, Surabaya, Medan, etc.)	Expands access to basic infrastructure (roads, clean water, sanitation), community-based approach with technical assistance, strengthens local government capacity for inclusive settlement planning
16	Kampung deret program	Jakarta, Indonesia	Gradual home improvements for slum dwellers, provides financial aid to low-income households for housing quality improvement
17	Community action plan for settlement improvement	Surabaya, Indonesia	Community-based planning for informal settlement upgrading, engages residents in decision-making and neighborhood improvements
18	Thematic village revitalization	Semarang, Indonesia	Transforms slum areas into thematic neighborhoods based on creative economy, establishes settlements as community-based tourism destination
19	Reblocking for settlement reorganization	Zambia (chibolya informal settlement project), Cape Town, South Africa	Reorganizes informal settlement layouts without evictions, enhances road access, drainage, and basic services without displacing residents
20	TITRIT program (legalizing slum tenure rights)	Morocco	Grants land ownership rights to informal settlement residents, improves access to credit and public services
21	Metrocable & vertical infrastructure for accessibility	Medellín, Colombia	Builds cable car transportation systems to connect hillside informal settlements with city centers, reduces social isolation and increases economic opportunities
22	Incremental housing	Angola (mussulo project), Thailand (baan mankong program)	Provides materials and housing designs for residents to construct homes gradually based on economic capacity
23	Climate-resilient slum upgrading	Dhaka, Bangladesh, Jakarta, Indonesia	Uses flood-resistant housing designs, rainwater management systems, and urban greening to address climate change effects
24	Rental housing & co-housing for low-income residents	Singapore (public rental housing scheme), Hong Kong (subsidized housing program)	Provides affordable rental housing for low-income residents, reduces informal settlement growth by offering affordable housing alternatives
25	Inclusive urban regeneration	Seoul, South Korea (cheonggyecheon stream restoration), Tokyo, Japan	Revitalizes slum areas into green and commercial spaces without displacing residents

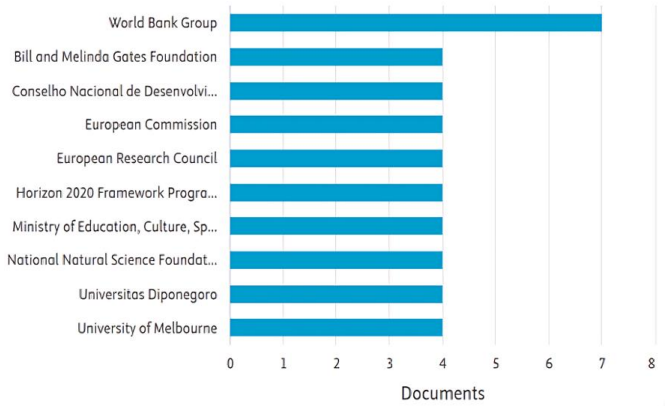

Figure 13. Research based on sponsor funding (Source: Authors' own elaboration)

The dominance of international institutions in funding research highlights their crucial role in supporting slum upgrading, which requires a multidisciplinary approach integrating technology, resource management, and community empowerment. International sponsorship facilitates research that develops innovative and sustainable solutions, strengthens local capacities, and provides access to evidence-based policies that reduce inequalities and improve quality of life. Without this support, many slum improvement initiatives would struggle to materialize efficiently, given the resource limitations in developing countries (**Figure 13**).

Global Slum Upgrading Strategy and Its Implementation

Slum upgrading, or the improvement of informal settlements, is a multifaceted strategy aimed at enhancing the physical, social, and economic conditions of communities in informal areas. Based on various approaches implemented across different countries, this strategy can be analyzed through several key aspects: community engagement, cross-sector collaboration, policies and regulations, technological innovation, and environmental and social resilience.

The strategy for slum upgrading involves various approaches aimed at improving the quality of life for residents in informal settlements. Community-based approaches, such as the know your city campaign, allow residents to actively participate in city planning, while collaboration between the government, private sector, and NGOs accelerates the provision of basic infrastructure. Land tenure legality, as applied in the Favela Bairro in Brazil, helps reduce the risk of eviction and improves access to public services. Technological innovations, such as the use of GIS and drones, facilitate the mapping and monitoring of settlement conditions. In addition, climate resilience strategies, as implemented in Jakarta and Dhaka, strengthen the resilience of settlements against natural disasters. But each strategy faces challenges, such as funding limitations, bureaucracy, and local politics, necessitating sustainable and evidence-based policies for slum upgrading programs to provide long-term positive impacts.

Relationship between Slum Upgrading and the achievement of the SDGs

Slum upgrading supports several SDGs by reducing poverty (SDG 1), improving health through better sanitation (SDG 3), and enhancing access to clean water (SDG 6) (**Table 4**). It promotes social inclusion and equality (SDG 10), improves housing quality and urban planning (SDG 11), and boosts climate resilience through disaster-resistant infrastructure (SDG 13). In summary, slum upgrading fosters sustainable and inclusive urban development.

Slum upgrading contributes to SDG 11 by enhancing infrastructure, access to clean water, sanitation, and environmental resilience (**Table 5**). Programs in countries like Indonesia and India also support economic well-being and public health. However, challenges such as land ownership, community participation, and political dynamics remain obstacles. Effective solutions include securing land rights, community involvement, and integration with economic and health policies. With the right approach, slum upgrading can create more inclusive, resilient, and sustainable cities.

Slum upgrading faces various challenges that can hinder the achievement of SDGs (sustainable cities and communities) (Seçmen & Ibrahim, 2025) (**Table 6**). One of the main obstacles is the lack of community participation, which often leads to resistance if the project does not align with residents' needs (Di Maddaloni & Sabini, 2022). The difference between formal regulations and social practices also complicates the transition from informal to formal settlements. Land ownership uncertainty is a major barrier, as many residents live without clear legal status, increasing the risk of eviction and limiting access to basic services (Malik et al., 2020). Project funding is also a challenge, as high costs and inaccurate budget estimates often cause delays.

Table 4. Relationship between slum upgrading and SDGs

No	SDG	Related to slum upgrading	Positive impacts of slum upgrading
1	SDG 1 (no poverty)	Reducing poverty levels in urban areas	Providing access to decent housing, basic services, and economic opportunities for the poor
2	SDG 3 (good health and well-being)	Improving health conditions in slum areas	Reducing diseases due to poor sanitation, improving access to healthcare facilities, and providing a cleaner environment
3	SDG 6 (clean water and sanitation)	Improving access to clean water and sanitation facilities	Providing clean water, better waste disposal systems, and reducing environmental pollution
4	SDG 10 (reduced inequality)	Enhancing social and economic inclusion for slum residents	Providing land rights, access to basic services, and reducing disparities in access to urban infrastructure
5	SDG 11 (sustainable cities and communities)	Target 11.1. Ensuring access to adequate housing and basic services	Improving housing quality, infrastructure, and safety for slum dwellers
		Target 11.3. Promoting inclusive and sustainable urbanization	Ensuring better and more participatory urban planning for the urban poor
6	SDG 13 (climate action)	Enhancing resilience to climate change and disasters	Building disaster-resistant houses, better drainage systems, and environmental greening

Table 5. Main contributions of slum upgrading to SDG 11

No	Aspect	Slum upgrading contribution	Implementation example
1	Improving living conditions	Improving physical environments such as housing, infrastructure, and basic services	Programs in Indonesia target 0% urban slum settlements through improved housing and infrastructure
2	Enhancing resilience	Strengthening community resilience against climate change and environmental challenges	The upgrading model in Semarang, Indonesia, focuses on enhancing the resilience of coastal communities to environmental and social risks
3	Promoting inclusivity and social equality	Ensuring land ownership rights and legal rights for slum residents	Resolving land ownership issues in Tegal City, Indonesia, is key to the success of upgrading programs
4	Health and well-being	Addressing environmental factors affecting health, including access to clean water and healthcare services	Integrating Health Impact Assessments (HIA) into urban policies improves health outcomes from upgrading programs
5	SDG 11 indicators	The proportion of the population living in slums and informal settlements as a key indicator of SDG 11 achievement	Studies in Tirunelveli and Chennai, India, use this indicator to assess the effectiveness of upgrading programs
6	Settlement status changes	Evaluating slum development in Chennai categorizes slums as existing, emerged, expanded, and evicted	Provides insights into the dynamics of slum changes over time
7	Economic impact	Slum upgrading relates to access to adequate housing, influenced by income, education level, and socio-economic status	A study in India shows improvements in road infrastructure, water supply, electricity, sanitation, and educational and healthcare facilities
8	Social contribution	Improving access to basic services like water, sanitation, education, and healthcare, and empowering communities	The Asha Community Health and Development Society in Delhi, India, demonstrates improvements in health and social equality through a multisectoral approach

Table 6. Challenges and barriers in integrating slum upgrading with SDGs

No	Challenge	Description	Case example
1	Land ownership issues	Uncertainty regarding land ownership status is a crucial factor in the success of upgrading projects.	A key factor in upgrading projects in Tegal City, Indonesia
2	Community participation	The level of citizen involvement affects the sustainability of the project. Top-down approaches often fail to build local support.	High participation increases social resilience and community cohesion.
3	Economic and social factors	The economic conditions of the community affect the effectiveness of upgrading. Socio-economic disruptions caused by the project can slow down implementation.	Programs that integrate economic benefits have a larger impact.
4	Political competition & resources	Projects are often influenced by political interests and uneven resource distribution.	Bias toward local elites has been found in several upgrading projects.
5	Informal-formal continuity	The transition from informal settlements to formal housing must consider the social dynamics that have already been established.	Barriers arise when the formalization process conflicts with the community's social structure.
6	Social challenges	High population density and unplanned layouts create logistical challenges and resistance from residents.	Conflicts arise when new regulations conflict with the community's customs.
7	Economic challenges	High costs, long project durations, and economic disruptions for residents can hinder implementation.	Mismatch between government services and residents' priority needs.
8	Environmental challenges	Adaptation to climate change needs to be integrated into upgrading projects, including water resource management.	The integrated water resources management approach is needed for urban resilience.
9	Policy & governance challenges	Lack of coordination between government, NGOs, and the community, as well as inconsistent policy changes.	Political dynamics and lack of trust among stakeholders often hinder upgrading projects.
10	Technical & technological challenges	Limited technology suitable for slum conditions, lack of infrastructure innovation, and challenges in providing sustainable water, sanitation, and energy.	Upgrading projects in several developing cities face difficulties in adopting cost-effective and sustainable technologies.
11	Health & welfare challenges	The spread of diseases due to unhealthy environments, lack of access to healthcare services, and psychosocial impacts from the relocation of residents.	Dharavi, India, shows that infrastructure improvements without healthcare support are less effective in improving quality of life.

Additionally, upgrading projects can disrupt residents' economy, for example, by losing livelihoods during the construction process.

At the governance level, political competition and uneven resource distribution often hinder the effectiveness of upgrading (Yeboah et al., 2021). Lack of coordination between the government, NGOs, and the community complicates the implementation and sustainability of the project. Environmental impacts and climate change must also be considered, particularly in water management and sustainable infrastructure (Nikolaou et al., 2020). To address these challenges, an inclusive, collaborative, and sustainable approach is required. Synergy between the government, private sector, NGOs, and local communities is key to ensuring that slum upgrading not only improves infrastructure but also enhances long-term socio-economic welfare of community.

Table 7. Intellectual structure and research avenue

No	Clusters	Research avenue
1	Infrastructure and sanitation upgrades	1. Develop a comprehensive construction planning framework to optimize decisions and accelerate sanitation service provision.
		2. Investigate the impact of integrating BIM and M&E on slum upgrading projects.
		3. Examine the best practices for cost-effective and sustainable sanitation solutions in informal settlements.
2	Policy and governance	1. Analyze the role of national policies and dedicated ministries in fostering effective slum upgrading programs.
		2. Explore how political dynamics, policy evolution, and strong city-level leadership influence project success.
		3. Assess governance models that enhance stakeholder collaboration and minimize bureaucratic barriers.
3	Community participation	1. Study participatory approaches that ensure slum dwellers play an active role in decision-making.
		2. Investigate how resident leadership and co-design methods impact the long-term success of upgrading projects.
		3. Develop frameworks to incorporate local knowledge and preferences into slum upgrading planning.
4	Entrepreneurial and economic development	1. Examine the barriers to entrepreneurship in slums, including tenure insecurity and trust in government authorities.
		2. Identify policies that facilitate microfinance access and economic opportunities for slum residents.
		3. Study the effectiveness of skills training programs in fostering sustainable livelihoods within upgraded communities.
5	Health and environmental benefits	1. Conduct comprehensive health impact assessments to document the benefits of slum upgrading.
		2. Explore the role of urban health frameworks in improving sanitation, air quality, and disease prevention.
		3. Assess the impact of integrating green infrastructure into slum redevelopment projects.
6	Technological innovations	1. Investigate the use of digital tools such as GIS-based mapping and survey applications in slum upgrading.
		2. Examine the integration of smart technologies for real-time monitoring of infrastructure improvements.
		3. Identify scalable digital solutions for data collection and decision-making in slum development initiatives.
7	Integrated frameworks for slum upgrading	1. Develop holistic models that combine infrastructure, policy, community participation, and technology for more effective slum upgrading solutions.
		2. Analyze case studies of integrated frameworks to identify key success factors.

CONCLUSION

This study examines global trends in slum upgrading using a bibliometric approach. The analysis results indicate that the number of publications in this field has steadily increased in recent years, with a primary focus on sustainable solutions and urban governance policies. Citation structure analysis suggests the presence of several key works that serve as essential references for the development of this research area. Additionally, findings reveal that numerous authors, institutions, and countries actively contribute to this research, with a dominance of nations undergoing rapid urbanization and the need for slum quality improvement.

The strategies for slum upgrading implemented globally vary, including community-based approaches, government policy interventions, and integration with sustainable technology and infrastructure. This study also highlights that slum upgrading is closely linked to the achievement of the SDGs, particularly in poverty alleviation, the provision of adequate infrastructure, and the development of inclusive and sustainable cities. Furthermore, the identification of significant themes in this research reveals opportunities for further studies, especially concerning the effectiveness of slum upgrading strategies, policy innovations, and the integration of multidisciplinary approaches to achieving sustainable development objectives.

This study proposes emerging research questions and directions, informed by in-depth content analysis of co-citation clusters. As a result, key issues and knowledge gaps in slum upgrading research are identified, and several new research pathways are proposed to address them (see **Table 5**). These findings not only contribute to understanding the evolving research dynamics but also offer insights for academics and policymakers in designing more effective, sustainable, and evidence-based slum upgrading strategies.

Table 7 indicates that slum upgrading research encompasses various key aspects. The infrastructure and sanitation improvement cluster highlights the optimization of construction planning and the integration of building information modeling (BIM) and monitoring & evaluation (M&E) to enhance project efficiency, along with sustainable and cost-effective sanitation solutions. The policy and governance cluster discusses the role of national policies, political dynamics, and urban leadership in the success of slum upgrading projects, focusing on improving stakeholder collaboration and reducing bureaucratic barriers. Meanwhile, the community participation cluster emphasizes resident involvement in decision-making through co-design methods and community leadership to ensure project sustainability.

From an economic and technological perspective, the entrepreneurship and economic development cluster highlights barriers to entrepreneurship in slum areas, such as land tenure insecurity and limited access to microfinance, and explores solutions through supportive policies and skills training programs. The health and environmental benefits cluster focuses on assessing health impacts, improving sanitation, air quality, and integrating green infrastructure. The technological innovation cluster explores the use of digital technologies such as GIS mapping and smart technologies for infrastructure monitoring. Finally, the integrated framework cluster emphasizes the need for models that combine multiple aspects to create more effective solutions.

This study identifies research pathways that can enhance the effectiveness of slum upgrading projects while supporting the achievement of SDGs.

Managerial Implications

Bibliometric research on global trends in slum upgrading has significant practical implications for policymakers, academics, and development organizations. Understanding

research trends and citation structures enables stakeholders to access the most influential studies, facilitating evidence-based policymaking. Moreover, identifying the most active contributors in this field allows governments and research institutions to establish strategic collaborations with productive scholars or institutions in slum upgrading research. This can accelerate the adoption of innovative and globally informed solutions in local contexts.

In practice, various widely studied slum upgrading strategies such as in-situ upgrading, resettlement, and public-private partnerships can be contextually adapted based on local social and economic conditions. Governments and international organizations can utilize insights from bibliometric trends to inform policy development for addressing slum settlements. Additionally, slum upgrading is closely linked to achieving the SDGs, particularly SDG 11, which focuses on sustainable cities and communities. Therefore, programs may benefit from alignment with SDG 11 indicators, including access to adequate housing, sanitation, and inclusive urban infrastructure.

Future studies may explore the role of emerging technologies such as big data analytics, GIS, and AI in enhancing urban mapping and planning for slum upgrading. Furthermore, innovative financing mechanisms, including blended finance and social investment, present relevant avenues for research to support long-term program sustainability. The increasing vulnerability of slum settlements to climate-related risks also underscores the need for research into climate-resilient upgrading strategies. In addition, research on participatory planning methods can deepen understanding of how community involvement influences program sustainability. Finally, longitudinal impact assessments on the social, economic, and environmental outcomes of slum upgrading initiatives represent a key future research direction to assess long-term effectiveness.

Limitations

Although this bibliometric study provides comprehensive insights into global trends in slum upgrading, several limitations should be acknowledged. First, Scopus may exclude grey literature and region-specific studies not indexed in global databases. Second, while bibliometric approaches reveal structural patterns and publication trends, they may not fully capture policy impact or implementation outcomes in real-world settings. Third, many studies on slum upgrading are conducted within specific local contexts, making it necessary to exercise caution when generalizing findings on a global scale.

Future Direction

To address these limitations, future research can focus on several key aspects. First, conducting a multi-source analysis by integrating data from various academic databases and policy reports from international organizations such as UN-Habitat and the World Bank can provide a broader and more inclusive perspective. Second, enhancing the bibliometric approach with qualitative methods such as content analysis or case studies can offer deeper insights into the real-world implications of slum upgrading strategies across diverse contexts. Third, further exploration into the integration of technology, including the use of AI, GIS, and big data for mapping and analyzing slum settlements, could significantly advance research and planning. Additionally, future studies should examine innovative financing models, such as community-based investments and sustainable financial frameworks, to support long-term development. Finally, investigating the relationship between slum upgrading and climate resilience is crucial to ensure that such programs contribute not only to improved socio-economic conditions but also to more resilient and sustainable urban environments.

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