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Research Paper

Community-centric AI applications in Urban renewal

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ABSTRACT

This study explores the transformative potential of Artificial Intelligence (AI) in enhancing community engagement in urban regeneration projects. AI's ability to process large datasets and predict trends is revolutionizing urban planning, fostering more inclusive and responsive urban ecosystems. We employed a bibliometric literature review to analyze existing research, focusing on AI's role in democratizing decision-making by aggregating and analyzing residents' opinions. Key findings include AI's effectiveness in addressing urban issues such as traffic congestion, environmental degradation, and public safety. Despite the benefits, challenges such as data privacy and algorithm transparency are significant. The research advocates for robust policy frameworks and adaptive governance models to ensure equitable benefits. Conclusively, AI can significantly contribute to creating smarter, more resilient, and inclusive urban environments.

1. Introduction

In the age of Artificial Intelligence (AI), the traditional approach to urban management processes seems outdated, with an accelerated shift due to AI intervention [1, 2]. AI's ability to process large-scale datasets, predict future trends, and optimize resource allocation is revolutionizing urban planning, management, and development [3, 4]. This technological advancement is not only a trend but also an important step towards an efficient and responsive urban ecosystem [5]. While traditional urban regeneration projects are usually led by governments, investors, and developers, community participation is often marginalized. AI intervention in urban planning promotes the democratization of the decision-making process [6, 7]. However, AI technology has enabled more inclusiveness and resident participation in the planning process [8, 9]. By using AI to gather and analyze residents' opinions and needs, urban planners can better tailor development projects to the realities of the community and meet residents' expectations [10]. The importance of community engagement in urban regeneration is indisputable. AI transforms large amounts of data into actionable insights by providing tools to aggregate community feedback, identify common concerns, and propose solutions accordingly [11]. This participatory approach democratizes urban planning and enhances transparency and accountability [12]. Recent urban renewal efforts in Mosul highlight the importance of community involvement, particularly in areas with historical significance [13]. AI transforms large amounts of data into actionable insights, which is crucial for building a collaborative environment where the voices of residents cannot be ignored in urban development [14]. The application of AI in urban regeneration can address a number of specific urban issues such as traffic congestion, environmental degradation and public safety [15, 16]. The quality of life of residents can be significantly improved by utilizing AI for full-time traffic management, environmental monitoring, and predictive policing [2]. AI can provide customized solutions to the unique needs of each community, thus ensuring that interventions are effective and sustainable [1]. One of the effective ways of urban planning lies in the integration of technological innovation with community-centered approaches to lay the foundations for efficient, sustainable, equitable, and democratic cities [7]. AI can help planners develop strategies that promote environmental sustainability, economic viability, and social equity by using data collection to accurately analyze and predict models [6]. This approach ensures that urban development meets both current needs and future challenges [5]. By utilizing the capabilities of AI, urban planners can promote community engagement, address specific urban challenges, and promote sustainable development [11].

2. Literature review

2.1 AI applications in urban renewal

The application of Artificial Intelligence (AI) in urban renewal exhibits significant interdisciplinary potential. AI's decision-making support for urban planning allows for the optimization of spatial structures and functional layouts through extensive urban data analysis. Study such as by [12] have demonstrated AI's efficacy in traffic management by alleviating congestion and enhancing travel efficiency through real-time monitoring and signal control. However, while these studies provide promising results, they often need comprehensive long-term assessments of the sustainability and scalability of these AI applications. In urban planning and design, AI facilitates the automation of planning processes, improving design efficiency and expediting the generation of land-use plans.the [17, 18] highlight AI's integration with remote sensing technologies for real-time environmental monitoring, promoting sustainable development. The integration of AI technologies in urban planning has shown promising results, as demonstrated by multi-agent systems facilitating stakeholder consensus in land use decisions [19]. Additionally, the role of ICT in enhancing urban services and improving quality of life has been well documented [20]. Despite these advancements, studies frequently need to pay more attention to the potential environmental impact of AI technologies and the energy consumption associated with their implementation.

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Nomenclature			
AI	Artificial Intelligence	*ICT*	Information and Communication Technology.
GO	Globalcoordination	*ES*	ethical standards

AI's contribution to public space optimization is also notable, enhancing functionality and attractiveness by analyzing usage patterns, as discussed by [21,22]. While these studies provide valuable insights, they often fail to consider the diverse needs of different community groups, leading to solutions that may not be universally applicable. Additionally, AI's role in historical and cultural preservation through digital means, as explored by [10,23], demonstrates excellent potential but requires further exploration into the ethical implications of digital heritage management. Digital twin technology, highlighted by [2,24], provides new perspectives for urban planning by creating virtual city replicas. While the theoretical benefits are clear, practical implementation remains challenging, and these studies frequently omit the complexities and costs associated with developing and maintaining digital twins. Furthermore, AI's role in enhancing resident services and community governance, as noted by [25,26], is promising but requires further investigation into the social implications and potential biases in AI-driven service provision.

2.2 Community participation and AI

AI significantly enhances community participation in urban regeneration projects by supporting decision-makers through urban data analysis. Studies by [27,28] illustrate AI's role in developing efficient regeneration strategies. However, these studies often need a more critical evaluation of the potential exclusion of less tech-savvy community members. AI platforms enabling direct resident participation, as explored by [29,30], show promise but need more robust frameworks to ensure equitable access and engagement. Real-time monitoring and feedback mechanisms, highlighted by [31,32], enhance community involvement but often overlook the challenges of data privacy and security. Personalized service provision, discussed by [28,33], enhances satisfaction but may inadvertently reinforce existing inequalities if not carefully managed. As noted by [9,14,24,34] risk prediction and management support by AI is crucial but requires critical evaluation of the accuracy and reliability of these predictive models. AI's role in cultural heritage protection, as explored by [10,23], and environmental monitoring, as discussed by [26,35], highlights significant benefits but also raises ethical concerns regarding data ownership and cultural sensitivity. The innovation in community governance models, highlighted by [4,36], shows potential but necessitates a further examination of the social implications and inclusivity of AI-driven governance platforms.

2.3 Challenges and ethical considerations

The integration of AI in urban regeneration presents numerous challenges and ethical considerations. Data privacy and security are paramount concerns, as AI systems rely on extensive personal data, posing risks of privacy violations if mishandled, as noted by [37,38]. The transparency and interpretability of AI algorithms are crucial for maintaining community trust and avoiding biases, which could exacerbate social inequalities, as discussed by [32,37–43]. Addressing the digital divide is essential to ensure equitable benefits from AI-driven urban renewal initiatives. Studies by [41,44] highlight the potential for AI to reinforce existing disparities if not carefully managed. The ethical implications of technological unemployment, as AI may replace specific jobs and raise employment concerns, are also significant, as discussed by [8,37–40,43]. Reduced community engagement due to high technology dependence and overshadowing human intuition and experience are further challenges, as noted by [45]. Robust policy frameworks and adaptive governance models are essential to address these challenges. These frameworks should facilitate flexible and synergistic interactions among stakeholders, addressing policy and social issues through agile communication, as [46] proposed. Global coordination, (GC), and ethical standards (ES) are crucial for managing AI's societal impacts and promoting the technology's positive use for the greater good, as highlighted by [43].

2.4 Policy and governance

Globally, the rapid development of AI technologies has led to significant societal changes and economic opportunities while presenting new challenges for policymakers and governance institutions [39,47]. Various countries and regions have developed various policy frameworks and governance models to integrate AI effectively and ensure its positive impact [23,48]. These policy frameworks emphasize the pivotal role of enterprises in the innovation process. Governments provide guidance and support, empowering enterprises to generate ideas, develop designs, open resources, and demonstrate applications. This approach supports innovation leadership and fosters the creative application of new technologies, promoting resource sharing and technology integration among different innovation actors through open integration [40]. However, while the involvement of enterprises is crucial, the potential for monopolization and uneven resource distribution remains a concern, necessitating balanced regulatory oversight. Collaborative governance is central to these policy frameworks, respecting the development trajectory of AI and providing institutional support for scenario innovation through joint government and market participation. This collaborative approach aims to coordinate innovation development with regulatory norms. Adaptive governance frameworks, such as those proposed by Tsinghua University's Institute for International Governance of Artificial Intelligence, emphasize synergistic interaction, multi-dimensional co-governance, and hierarchical governance among stakeholders, addressing policy and social issues through flexible interaction and agile communication [46]. Despite the benefits, implementing such adaptive frameworks can be challenging due to varying degrees of technological maturity and regulatory environments across regions. Global coordination is another crucial aspect of AI governance, recognizing the worldwide challenges posed by technological development. It calls on the international community to urgently collaborate in building a collective future. Enhanced rule of law provides a solid foundation for the reliable and credible development of AI, while ethical norms guide the technology's development towards beneficial outcomes[49]. However, achieving global consensus on AI regulations and ethical standards is complex and requires continuous diplomatic efforts and mutual understanding among nations. Furthermore, specific regulatory measures have been formulated to ensure AI applications' safety, fairness, and ethics in critical areas such as algorithms, data privacy, autonomous driving, and health and wellness. These measures aim to balance technological advancement with societal needs, promoting the healthy development of AI while minimizing potential negative impacts [9,50]. Notably, the dynamic nature of AI technology necessitates ongoing revisions and updates to these regulatory frameworks to address emerging challenges, reassuring the audience about the adaptability of AI governance and ensuring their relevance and effectiveness. AI's integration into urban renewal initiatives offers transformative potential for democratizing decision-making, enhancing quality of life, and supporting sustainable development. Aggregating and analyzing community opinions ensures that urban regeneration projects align with resident expectations. AI's applications in traffic management, environmental monitoring, and public safety directly improve urban living conditions. Predictive analytics assist planners in making data-driven decisions for long-term sustainability. Despite the benefits, addressing data privacy, algorithm transparency, potential biases, the digital divide, and cultural sensitivity is critical. Comprehensive strategies and robust policy frameworks are necessary to mitigate these challenges. By implementing these strategies, AI can create more intelligent, resilient, and inclusive urban environments.

3. Method

The aim of this study is to explore the transformative potential of Artificial Intelligence (AI) in enhancing community engagement in urban regeneration projects, to assess its effectiveness, ethical considerations and policy frameworks, and to provide practical recommendations for creating smarter, more resilient and inclusive urban environments. This study undertakes a comprehensive exploration of the role of artificial intelligence (AI) in enhancing community participation in urban renewal. The research addresses the benefits, challenges, ethical considerations, and policy frameworks pertinent to AI integration, providing a holistic perspective on the subject.In this study, we employ a bibliometric literature review to statistically analyze the existing research on community-centered AI applications in urban renewal. This approach is crucial as it allows us to systematically identify, evaluate, and synthesize a vast array of academic publications in the field [32]. By leveraging bibliometric techniques, we can uncover trends, research hotspots, and influential works, providing a comprehensive overview of the current state of knowledge [51]. This method is particularly important for this study as it helps to objectively quantify the impact and development of community-centric AI applications, highlighting gaps and opportunities for future research [52]. Ultimately, the bibliometric analysis facilitates a deeper understanding of how AI can be effectively integrated into urban renewal projects to enhance community engagement and outcomes[53]. We chose Scopus as our primary database for several reasons. Scopus is renowned for its extensive coverage of peer-reviewed literature across various disciplines, ensuring a comprehensive and multidisciplinary approach to our review [54]. Additionally, Scopus provides robust tools

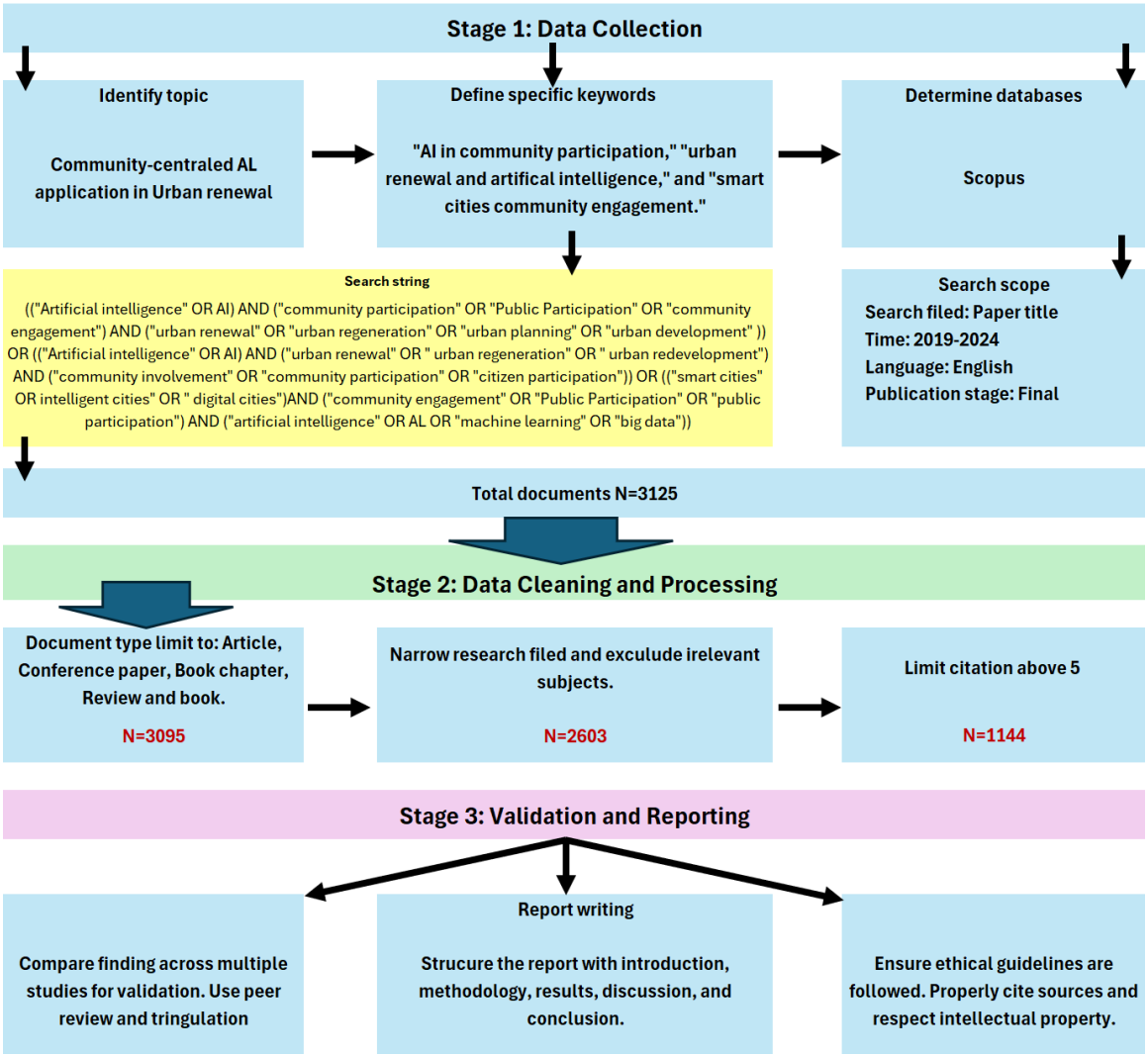

Figure 1. Operational framework.

for citation analysis, which are crucial for identifying influential works and research trends [55]. By leveraging these tools, we can objectively quantify the impact and development of community-centric AI applications [56]. Although this study employs bibliometric methods for data analysis, this is not the main purpose of the research. The primary aim remains the qualitative analysis of the literature to discuss related studies under this topic. Figure 1 presents the process of this study, first stage involved identifying the research topic which is ”Community-Centered AI Applications in Urban Renewal.SSubsequently, specific keywords were defined to capture relevant studies comprehensively. The keywords used were: ÄI in community participation,urban renewal and artificial intelligence,änd ßmart cities community engagement.”The following search string was used to conduct the search in Scopus:
((“Artificial Intelligence” OR AI) AND (“community participation” OR “public participation” OR “community engagement”) AND (“urban renewal” OR “urban regeneration” OR (“urban planning” OR “urban development”)) OR ((“Artificial Intelligence” OR AI) AND (“urban renewal” OR “urban regeneration” OR “urban redevelopment”) AND (“community involvement” OR “community participation” OR “citizen participation”)) OR ((“Smart Cities” OR “Intelligent Cities” OR “Digital Cities”) AND (“community engagement” OR “community participation” OR “public participation”) AND (“Artificial Intelligence” OR AI OR “Machine Learning” OR “Big Data”)) NOT (medical OR health OR “healthcare”)
The search scope was limited to papers published between 2019 and June 2024, Fig. **??**, with the search field restricted to “Paper Title.” Only documents in English and at the final publication stage were included. This search yielded a total of n=3125 documents. The second stage focused on refining the dataset to ensure relevance and quality. Initially, document types were limited to articles, conference papers, book chapters, reviews, and books, which reduced the number of documents to n=3095. To further narrow the research field and exclude irrelevant subjects, additional filtering was applied, resulting in n=2603 documents.

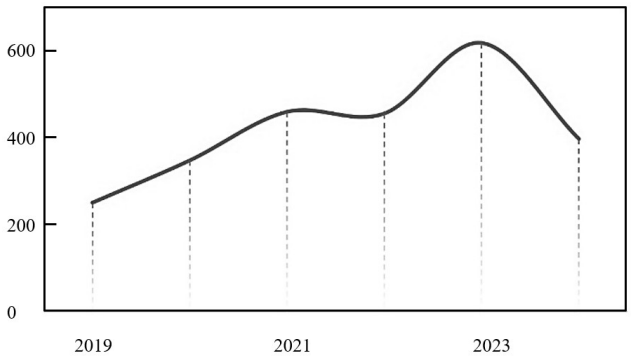

Figure 2. Number of Journals published in the last five years.

Subsequent to this step, two specific analyses were conducted: the number of articles published in the past five years, and the number of documents from the top 15 countries/regions, Fig. 3. These metrics provided insights into the temporal and geographical distribution of the research, highlighting recent trends and key contributing regions. Given the still substantial volume of documents, an additional criterion was employed: articles with fewer than five citations were excluded. This final step reduced the dataset to n=1144

documents, providing a manageable and relevant corpus for detailed analysis. In the final stage, the cleaned dataset was subjected to bibliometric analysis to identify key trends, research gaps, and the most influential works in the field of community-centered AI applications in urban renewal. Metrics such as publication count by year, country of origin, and citation analysis were employed to draw meaningful insights from the literature.

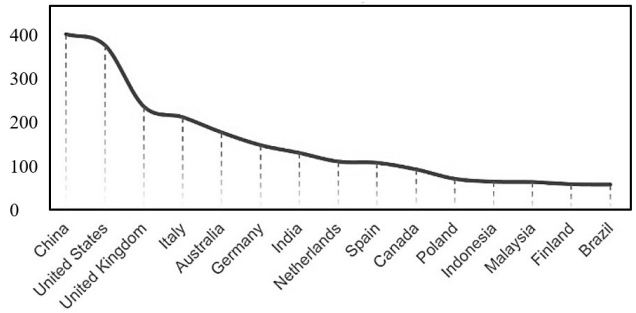

Figure 3**.** The number of documents from the top 15 countries/regions.

4. Result and discussion

Integrating AI technology in urban renewal has revealed several key themes, particularly in democratizing decision-making, enhancing quality of life, and promoting sustainable development. AI enables a more inclusive and transparent approach to urban planning by aggregating and analyzing community opinions and needs, ensuring urban regeneration projects align with resident expectations Additionally, AI improves urban services such as traffic management, environmental monitoring, and public safety, directly enhancing residents' quality of life. Furthermore, AI's predictive capabilities support sustainable urban development by helping planners make data-driven decisions that account for long-term trends and potential issues. However, the application of AI in urban renewal also presents significant challenges and ethical considerations. Data privacy and security are paramount concerns, as AI systems require large amounts of personal data, which, if mishandled, could violate privacy rights. Additionally, transparency and potential biases in AI algorithms can lead to mistrust and exacerbate social inequalities. The digital divide poses another challenge, as communities with limited access to technology may benefit differently from AI-driven urban renewal initiatives. Moreover, AI must respect cultural diversity to avoid marginalizing certain groups, ensuring inclusive and equitable urban development. To address these challenges, policy frameworks must support innovation and collaboration, with a particular emphasis on the role of enterprises and government guidance in driving AI development. Adaptive governance models should facilitate flexible and synergistic interactions among stakeholders, addressing policy and social issues through agile communication. Global coordination and ethical standards are crucial for managing AI's societal impacts, promoting the technology's positive use for the greater good. Regulatory measures must ensure the safety, fairness, and ethics of AI applications in critical areas, minimizing potential negative impacts while fostering sustainable urban development. By implementing these strategies, AI can significantly contribute to smarter, more resilient, and inclusive cities.

5. Conclusions

This study underscores the transformative potential of AI in urban renewal, focusing on its capabilities to democratize decision-making, enhance quality of life, and support sustainable development. AI's ability to aggregate and analyze community opinions ensures that urban regeneration projects align with residents' needs, promoting more inclusive and transparent planning. The technology's application in traffic management, environmental monitoring, and public safety directly improves urban living conditions. Additionally, AI's predictive analytics assist planners in making data-driven decisions for long-term sustainability. Case studies from Guangzhou, Tehran, and Barcelona demonstrate AI's effectiveness in fostering community participation and ensuring that urban renewal projects reflect diverse needs. These instances highlight AI's role in improving transparency, efficiency, and responsiveness in urban planning, resulting in greater community support and engagement. Despite these benefits, the study identifies critical challenges and ethical considerations, such as data privacy, algorithm transparency, potential biases, the digital divide, and cultural sensitivity. Addressing these issues requires robust policy frameworks and adaptive governance models. Such frameworks should support innovation, promote collaboration, and establish ethical standards and regulations to ensure the safe and fair use of AI. By mitigating these challenges and implementing comprehensive strategies, AI can significantly contribute to creating smarter, more resilient, and inclusive urban environments. This study highlights the importance of integrating AI into urban renewal efforts, emphasizing its potential to foster sustainable and livable cities for all residents.

Authors' contribution

All authors contributed equally to the preparation of this article.

Declaration of competing interest

The authors declare no conflicts of interest.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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