

Smart Circular Cities and Stakeholders Engagement: A Literature Review to Explore the Role of Artificial Intelligence

Sabrina Sacco, Ferdinando Di Martino, and Maria Cerreta(✉)

University of Naples Federico II, Naples, Italy
{sabrina.sacco,fdimarti,maria.cerreta}@unina.it

Abstract. The smart city concept describes the use of information and communication technologies (ICT) in a sustainable urban context to improve its services' efficiency and meet its inhabitants' requirements. This transition towards sustainability includes creating circular cities with a focus on the well-being of the entire ecosystem. By employing Artificial Intelligence (AI) systems and strategies for sustainable circular purposes, the aim of building a smart circular city is to raise the standard of living, optimize the utilization of resources, strengthen the relationships between various stakeholders and tackle climate, ecological, social and economic challenges. To be better fitted to the requirements of citizens and accelerate progress towards the SDGs, the AI models must include communities in the construction, implementation, and ongoing modification of AI systems, making a huge contribution to improving decision-making.

This study aims to investigate the direct and indirect relationships between AI, stakeholders' engagement, and the smart circular city, integrating the literature review with bibliometric maps elaborated through the VOSviewer tools. The findings of this study will contribute to defining the research gap about the role of AI technologies in encouraging and promoting stakeholders' participation in the collaborative decision-making process.

Keywords: Artificial Intelligence · Smart City · Stakeholders Engagement

1 Introduction

First introduced in the early 1990s, the concept of "Smart City" refers to an "urban labelling" phenomenon [1] generally related to the use of advanced technology and data analytics to improve the efficiency and sustainability of urban services and infrastructure [2–5]. Harrison et al. [6] defined a Smart City as an instrumented, interconnected, and intelligent city. However, the new urban challenges related to economic, environmental, ecological and social issues cannot be addressed only by increasing efficiency.

These challenges require new and innovative approaches to urban governance involving the "human factor" [7]. Creativity is a key driver to a Smart City, considering human and social infrastructure as crucial axes for city development [8]. Debates around Smart

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2023
O. Gervasi et al. (Eds.): ICCSA 2023 Workshops, LNCS 14108, pp. 239–258, 2023.
https://doi.org/10.1007/978-3-031-37117-2_18

Cities have been advanced by the introduction of the concept of Cognitive City, an intelligent urban environment that constantly learns through interaction with citizens. This relatively new concept allows the development of an interdisciplinary approach to deal with complex urban issues [9]. "The citizen becomes an active element of urban governance, not only through civic participation but also through serving as a sensor for the operational state of the urban infrastructure" [10].

In a Cognitive City, citizens predominantly not only get information on urban infrastructure, but also provide information to others regarding their behaviours in the urban environment [11]. "Citizens as human sensor networks" [10] involve citizens as active players and active co-producers of services through a great degree of information, awareness, and engagement.

Providing services that fulfil the city's objectives and foster social innovation issues, requires the recognition of the centrality of collective action and capacitation, yielding social benefits rather than individual ones and bringing new values to society [12].

In this perspective, a central role is given to initiatives promoting social inclusion and equal participation [13], developing an integrated approach to linking governments, businesses, schools, non-profits, and citizens. This integration would involve three key elements: the satisfaction of the interests of actors; changes in socio-political arrangements; and empowerment of the participating actors [14].

Creating an environment where citizens are empowered to make decisions that are socially and environmentally responsible allows for encouraging of a balance between the environment, economy and the social aspects of a community in a circular and sustainable perspective, promoting social inclusion, economic development and resilience.

Promoting a sustainable and circular future development [15–18], the United Nations has identified 17 Sustainable Development Goals (SDGs) [19], which require complementary actions by governments, civil society, science, and businesses. Stakeholder engagement is an important part of sustainable development, as it ensures that the interests of all stakeholders - citizens, civil society organizations, governments, businesses, and other entities - are taken into consideration when making decisions about social issues.

This engagement process helps to better understand the potential impacts of decisions and allows for a more informed decision-making process. Artificial Intelligence (AI) systems could help define strategies for sustainable circular purposes that tackle climate, ecological, social, and economic challenges [20–23].

The participatory AI model [24] refers to the practice of involving humans in the development, deployment, and ongoing refinement of artificial intelligence systems. These models could fit the requirements of citizens and accelerate progress towards the SDGs, including communities in the construction, implementation, and ongoing modification of AI systems, making a huge contribution to improving decision-making. In particular, the integration of AI and the SDGs can be an effective tool for improving community engagement. Through AI-driven technologies, collaborative decision-making processes could be informed. Participatory AI involves engaging diverse stakeholders, such as end-users, domain experts, and community representatives, throughout the AI development process to ensure that the technology aligns with their needs, values, and

priorities. AI can help to collect, analyse and interpret large amounts of data, targeting and addressing underrepresented stakeholders, identifying areas of need and potential areas of improvement and understanding the impacts of various initiatives.

AI can also be used to identify and prioritize potential development projects and programs. Integrating AI and stakeholder engagement requires understanding the various stakeholders involved and their respective roles in the process. Additionally, it's important to ensure that stakeholders are conscious of the purpose and scope of AI implementation. This approach can help to increase transparency, accountability, and trust in AI systems and can also help to identify and address potential biases and ethical concerns. The research intends to examine the scientific landscape of direct and indirect relationships that exist between AI, stakeholder engagement and smart circular city.

A bibliographic exploration done through the Scopus online database will be used to identify related articles, and the VOSviewer tool will be employed to build and illustrate the bibliometric networks.

The paper has been divided into three parts: Sect. 2 explains the methodology and the functional tools for bibliometric analysis; Sect. 3 presents the results of the study, including a literature review combined with the bibliometric maps of the scientific landscape; finally, Sect. 4 provides a discussion of the results and the conclusions.

2 Material and Methods

A literature survey has been implemented and visualised through the bibliometric approach of the scientific landscapes provided by van Eck and Waltman [25] (Fig. 1).

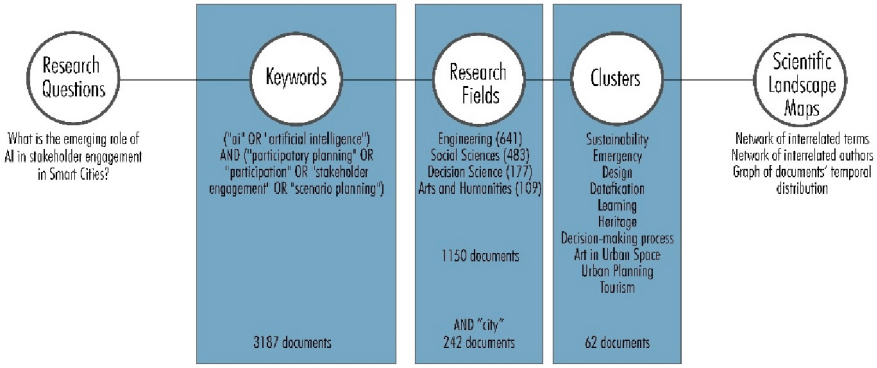

Fig. 1. The methodological steps for the scientific landscape maps.

The data collection process was carried out in the Scopus collection, a database for scientific publications, using the keywords ("ai" or "artificial intelligence") and ("participatory planning" or "participation" or "stakeholder engagement" or "scenario planning") to investigate the role of stakeholder engagement in processes using AI.

This generic research has allowed obtaining an interesting number of publications, for a total of 3187 documents. The database was filtered to refine the result obtained just,

including the papers related to Social and Urban Science, for a total of 1150 papers. Then, the result obtained was filtered again, also considering the keyword "city", obtaining a total of 242 papers.

All 242 papers were exported in CSV format from Scopus with their specific data, including the number of times that the article, author, source, country, and references were cited, in addition to the title, abstract and all keywords. This information was necessary to produce and analyse bibliometric maps. These maps were generated with VOSviewer version 1.6.19 [26]: software able to create maps based on network data to be visualised and explored. Moreover, the software manual [27] explains how the maps are constructed from elements and links: network elements are the objects of interest to characterise through the maps, for example, publications, researchers, or terms present within the papers; the relations are the links between two elements, such as co-authorship, co-occurrence, citation, bibliographic coupling or co-citation links, depicted by a line of variable thickness that corresponds with the strength of the connection. The elements can then be grouped into clusters, which are identifiable by different colours.

Additionally, the software provides different ways of visualising the generated maps: network visualisation, where the elements' proximity or lack displays the connection between them and the size indicates their weight; overlay visualisation, where the variation of default colours indicates the range of elements from the oldest to the latest; density visualisation, which can be queried to obtain a density map of both elements and clusters. For the current research, maps of the scientific landscape were generated from network data extracted from the Scopus database to build a network of co-occurrence links between terms. Then a literature review was conducted. From these 242 papers thus filtered, we proceeded with the selection, one by one, of the most pertinent articles for the topic of study, eliminating all those with inconsistent titles and abstracts. This resulted in a sample of 62 analysed articles: the oldest dated 2010 and the most recent published in 2023.

3 Results

The search for scientific literature in Scopus using the keywords related to "artificial intelligence" and "stakeholder engagement" gave results of 1150 papers published between 2008 and 2023. A network data analysis, generated in VOSviewer, was done to understand and visualise the distribution and relationship between the terms frequently found in these articles. Through this map was possible to identify four main clusters related to "data", "education" and "learning", "industry", "management" and "decision" (Fig. 2).

The results were further refined, focusing on the term "city". A total of 242 papers was obtained. A co-authorship, filtered by country, network data analysis generated by VOSViewer shows that most of the publications come from the United States and China (Fig. 3).

A new network data analysis was done based on the 242 studied articles. The "Overlay" visualisation of this analysis (Fig. 4) allows us to discover the most recurrent terms and their related themes and when they were first introduced in the discussion.

By selecting the terms most pertinent to the main topics, VOSviewer uses chromatic gradation to depict the transition from 2018 (blue) to 2021 (yellow), indicating how relevant these issues have become recently.

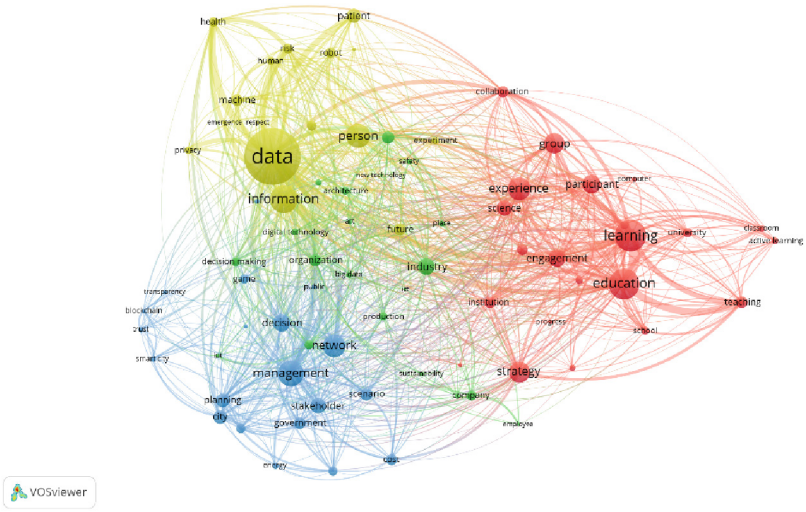

Fig. 2. VOSviewer network visualisation of the network data map based on 1150 documents.

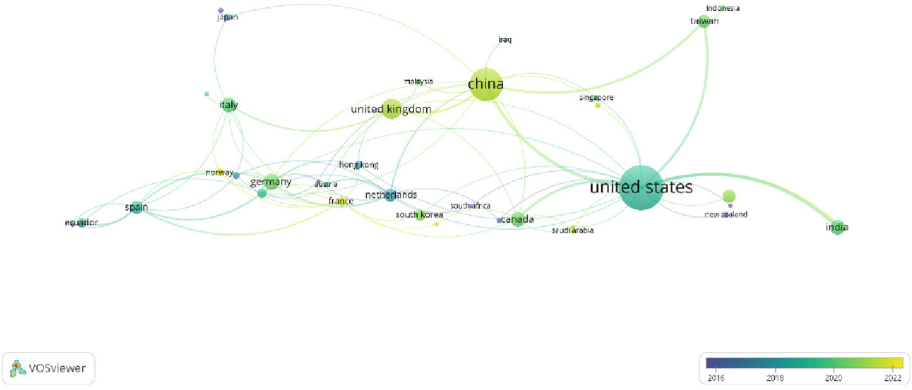

Fig. 3. VOSviewer network visualisation of the co-authorship filtered by country based on the bibliographic data of the 242 documents.

In 2018, terms such as "decision support system", "stakeholders", and "public participation" were widely used. During this time, AI was utilised in various ways to aid decision-making in various applications.

From 2019 to 2020, the debate investigated the possible connections of these terms to "city" and "urban planning". This was the first time the urban setting was explored as a field of study in terms of AI and stakeholder engagement. The yellow marks all the more widely shared terms between 2020 and 2021. The presence of "cultural heritage", "intangible cultural heritage", "big data", and "Smart City" in this cluster suggests that recent arguments point towards AI being pivotal in defining digital, sustainable, and circular growth processes in cities.

A selection, one by one, allows us to further filter the results. A total of 62 papers were analysed, as more relevant and related to the main topics of the research. A graph (Fig. 5) has been generated to facilitate the literature review. It is characterised by the years of publication (on the ordinates) and by the number of publications (on the abscissas) to understand the trend of publications on the topic of interest during the years. This graph shows the increasing interest in the research topics, especially from 2017 to 2022. Finally, the selected articles were classified into ten main clusters (Table 1).

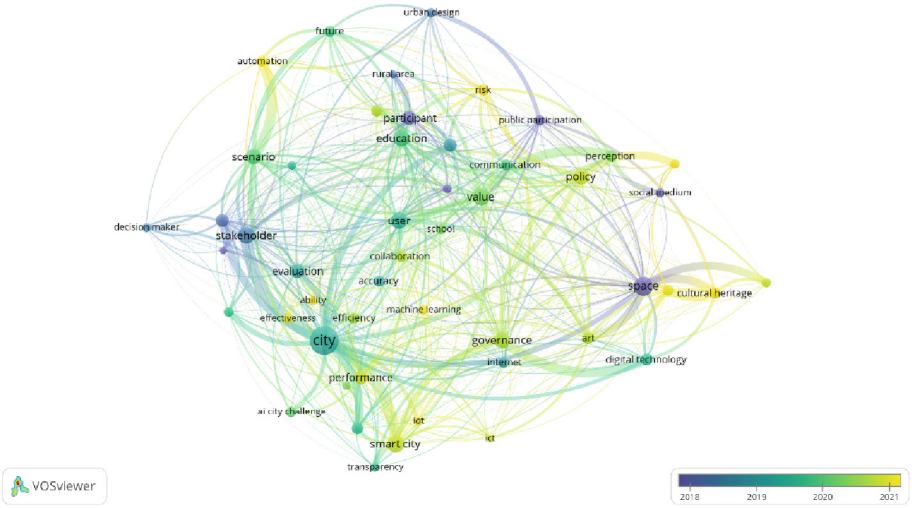

Fig. 4. VOSviewer network visualisation of the network data map's overlay based on the 242 documents.

Sustainability, in Terms of Sustainable City Growth. The implementation of AI technologies has the potential to revolutionize the current situation, promoting equal citizen participation and favouring sustainable growth. Deng et al. discuss how AI effectively investigates resource optimization strategies and model projections for resource-oriented cities. The authors emphasize that the success of these cities necessitates the involvement of governments, entrepreneurs, scientific research institutes, intermediary institutions and the general public. Gao et al. delve into the potential of AI to generate value from Open Government Data (OGD), which refers to information in the public sector that is available in open, reusable formats and free of charge. The goal of OGD is to ensure transparent administration and encourage citizen involvement. Sidani et al. provide a model based on a qualitative analysis of people's perceptions of how Smart Cities can promote sustainable social inclusion. Myeong et al. investigate how to incorporate data-driven approaches and citizen participation into efficient public sector pollution management in Smart Cities, encouraging integrated sensors and Big Data via the Internet of Things (IoT).

Emergency, in Terms of Strategies to Deal with Extreme Events. Recent advances in Deep Learning (DL) offer outstanding opportunities for modelling complex and dynamic

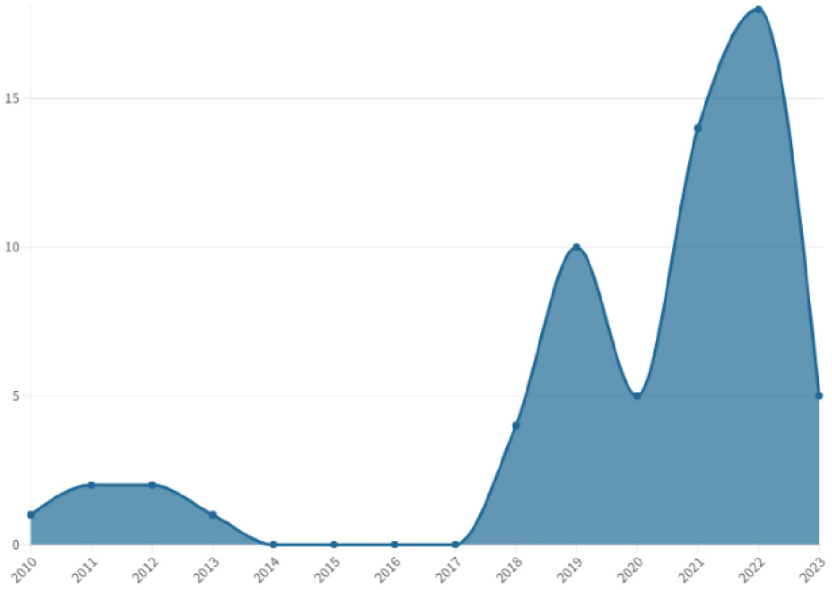

Fig. 5. Graph of the 62 articles published from 2010 to 2023 on the research topics.

systems, such as ecological, climate, and cyber systems. Hao et al. connect resilience theories with big urban data, utilising advanced urban sensing technologies and DL, to show how walkability, green spaces, and civic involvement can contribute to resilience. The findings demonstrate the mediating roles of communities' social and physical properties in diminishing the effects of extreme events, with data-driven proof. Li et al. devise a game to simulate the process when a city is struck by an earthquake that comprises one main shock and one aftershock. During the emergency response, citizens and the city, collaborate to finish the task of taking shelter and collecting data for regional damage evaluation. Smartphone-based monitoring techniques are identified to allow crowdsensing after extreme events, such as earthquakes.

Design, Including the Architectural and the Urban Scale Design. Dortheimer et al. suggest utilising novel information technologies to automate design interactions through crowdsourcing and AI technologies and promote citizen participation in the design process on an architectural scale. Quan creates the "Urban-GAN" system, a plural urban design computation system, to offer technical support for design empowerment and to enable the public to create their own designs. The system is composed of an urban form database and five process models, allowing users with little design knowledge to select urban form cases, generate designs and make design decisions. Burry compiles a catalogue of AI tools to direct urban development toward meaningful public participation in the urban design processes, with the goal of achieving more sustainable and resilient urban environments. Jutraž et al. analyse the pros and cons of various digital tools regarding their effectiveness in promoting public participation and education in urban

Table 1. Classification in ten clusters of the articles analysed.

Cluster	Year	Authors	Title
Sustainability	2023	Deng Y., Jiang W., Wang Z.	Economic resilience assessment and policy interaction of coal resource-oriented cities for the low carbon economy based on AI
	2023	Gao Y., Janssen M., Zhang C.	Understanding the evolution of open government data research: towards open data sustainability and smartness
	2022	Sidani D., Veglianti E., Maroufkhani P.	Smart Cities for a Sustainable Social Inclusion Strategy-A Comparative Study between Italy and Malaysia
	2021	Myeong S., Shahzad K.	Integrating data-based strategies and advanced technologies with efficient air pollution management in Smart Cities
Emergency	2023	Hao H., Wang Y.	Modeling Dynamics of Community Resilience to Extreme Events with Explainable Deep Learning
	2022	Li H., Chen X., Chen H., Wang B., Li W., Liu S., Li P., Qi Z., He Z., Zhao X.	Simulation of Smartphone-Based Public Participation in Earthquake Structural Response Emergency Monitoring Using a Virtual Experiment and AI
Design	2023	Dortheimer J., Yang S., Yang Q., Sprecher A.	Conceptual Architectural Design at Scale: A Case Study of Community Participation Using Crowdsourcing
	2022	Quan S.J.	Urban-GAN: An artificial intelligence-aided computation system for plural urban design

(*continued*)

Table 1. (*continued*)

Cluster	Year	Authors	Title
	2022	Burry M.	A new agenda for AI-based urban design and planning
	2010	Jutraž A., Zupančič T.	Evaluation of visual digital tools for public participation in urban design
Datafication	2022	Ziosi M., Hewitt B., Juneja P., Taddeo M., Floridi L.	Smart Cities: reviewing the debate about their ethical implications
	2022	Dyakonova M.A., Botasheva A.K., Kardanova M.L.	Socio-Economic and Political Transformation of "Smart Nations" as a Digital Society
	2022	Broomfield H., Reutter L.	In search of the citizen in the datafication of public administration
	2022	Roberts T., Zheng Y.	Datafication, Dehumanisation and Participatory Development
	2022	Marzá D.G., Calvo P.	Algorithmic democracy: a new structural change in public opinion?
	2021	Feher K.	Expectation of smart mentality and citizen participation in technology-driven cities
	2021	Singh U., Determe J.-F., Horlin F., De Doncker P.	Crowd Monitoring: State-of-the-Art and Future Directions
	2020	Alison Paprica P., Sutherland E., Smith A., Brudno M., Cartagena R.G., Crichlow M., Courtney B.K., Loken C., McGrail K.M., Ryan A., Schull M.J., Thorogood A., Virtanen C., Yang K.	Essential requirements for establishing and operating data trusts: Practical guidance co-developed by representatives from fifteen Canadian organizations and initiatives
Learning	2020	Jiang J.C., Kantarci B., Oktug S., Soyata T.	Federated learning in Smart City sensing: Challenges and opportunities

(*continued*)

Table 1. (*continued*)

Cluster	Year	Authors	Title
	2018	Pournaras E., Pilgerstorfer P., Asikis T.	Decentralized collective learning for self-managed sharing economies
	2018	Gugerell K., Platzer M., Jauschneg M., Ampatzidou C., Berger M.	Game over or jumping to the next level? How playing the serious game 'Mobility Safari' instigates social learning for a smart mobility transition in Vienna
Heritage	2022	Laužikas R., Žižiūnas T., Fomin V.	Novel Technologies as Potential Catalyst for Democratizing Urban Heritage Preservation Practices: The Case of 3D Scanning and AI
	2022	Li Q.	Intelligent Intangible Cultural Heritage Innovation Platform Under the Background of Big Data and Virtual Systems
	2022	Wang X., Liang M., Hou X., Song N.	Intelligent Computing of Cultural Heritage: A Case Study of European Time Machine Project
	2021	Kimura F., Ito Y., Matsui T., Shishido H., Kitahara I., Kawamura Y., Morishima A	Tourist Participation in the Preservation of World Heritage – A Study at Bayon Temple in Cambodia –
	2021	Flores-Ruiz D., Miedes-Ugarte B., Wanner P.	Relational Intelligence, Artificial Intelligence and Citizen Participation. The Case of the Cooperative Digital Platform Les Oiseaux de Passage
	2021	Yu X., Shan W., DIng H., Li B.	Research on Intangible Cultural Heritage Amusement Space Design from the Perspective of Artificial Intelligence

(*continued*)

Table 1. (*continued*)

Cluster	Year	Authors	Title
	2020	Mager T., Hein C.	Digital excavation of mediatized urban heritage: Automated recognition of buildings in image sources
	2019	Jeppson P.L., Muschio G., Levin J.	Computational Science, Convergence Culture, and the Creation of Archaeological Knowledge and Understanding
Decision-making process	2023	Zhou Y., Lei H., Zhang X., Wang S., Xu Y., Li C., Zhang J.	Using the Dual Concept of Evolutionary Game and Reinforcement Learning in Support of Decision-Making Process of Community Regeneration—Case Study in Shanghai
	2022	Purba F.N., Arman A.A.	A Systematic Literature Review of Smart Governance
	2022	Zhou Y., Chen J., Zhang X., Liu X., Lei H.	How to Support the Decision-Making Process of Community Regeneration proposed by Evolutionary Game and Reinforcement Learning? A case study in Shanghai
	2022	Rindzevičiūtė E.	AI, a wicked problem for cultural policy? Pre-empting controversy and the crisis of cultural participation
	2022	Mallah Boustani N., Merhej Sayegh M., Boustany Z.	Strengthening Public Institutions and Social Inclusion of Vulnerable Groups in A Developing Country - Innovation in Organizations and Artificial Intelligence Implications
	2022	Wilson C.	Public engagement and AI: A values analysis of national strategies

(*continued*)

Table 1. (*continued*)

Cluster	Year	Authors	Title
	2021	Weng M.-H., Wu S., Dyer M.	Ai augmented approach to identify shared ideas from large format public consultation
	2021	Haqbeen J., Sahab S., Ito T., Rizzi P.	Using decision support system to enable crowd to identify neighborhood issues and its solutions for policymakers: An online experiment at Kabul municipal level
	2021	Raineri P., Molinari F.	Innovation in Data Visualisation for Public Policy Making
	2021	Anastasiadou M., Santos V., Montargil F.	Which technology to which challenge in democratic governance? An approach using design science research
	2021	Hua Z.	Discussion Features of Public Participation in Space Governance in Network Media – Taking Yangzhou Wetland Park as an Example
	2019	Ramesh M.V.	Integration of participatory approaches, systems, and solutions using IoT and AI for designing smart community: Case studies from India
	2019	Shrestha R., Flacke J.	Leveraging citizen science to advance interactive spatial decision support technology: A swot analysis
	2019	Dixon B., Johns R.	Vision for a holistic Smart City-HSC: Integrating resiliency framework via Crowdsourced Community Resiliency Information System (CRIS)

(*continued*)

Table 1. (*continued*)

Cluster	Year	Authors	Title
	2019	Lee M.K., Kusbit D., Kahng A., Kim J.T., Yuan X., Chan A., See D., Noothigattu R., Lee S., Psomas A., Procaccia A.D.	Webuildai: Participatory framework for algorithmic governance
	2019	Duberry J.	Global environmental governance in the information age: Civil society organizations and digital media
	2019	Predescu A., Mocanu M.	Increasing Collaboration and Participation Through Serious Gaming for Improving the Quality of Service in Urban Water Infrastructure
	2019	Schütz L., Bade K.	Assessment user interface: Supporting the decision-making process in participatory processes
	2018	Boukchina E., Mellouli S., Menif E.	From citizens to decision-makers: A natural language processing approach in citizens' participation
	2018	Golini R., Guerlain C., Lagorio A., Pinto R.	An assessment framework to support collective decision-making on urban freight transport
	2012	Simm W., Whittle J., Nieman A., Portman A., Sibbald J.	OurCity: Understanding how visualization and aggregation of user-generated content can engage citizens in community participation
	2012	Skoric M.M., Pan J., Poor N.D.	Social media and citizen engagement in a city-state: A study of Singapore

(*continued*)

Table 1. (*continued*)

Cluster	Year	Authors	Title
	2011	Jensen M., Lowry P., Jenkins J.	Effects of automated and participative decision support in computer-aided credibility assessment
	2011	Mahmoud H., Arima T.	A web-based public participation system that supports decision making
Art in Urban Space	2022	Jiang X., Wang F., Jiang Z.	Study on the Path of Continuous Participation of Digital Art in Public Space in 6G IoT Communication
Urban Planning	2021	Kaklauskas A., Bardauskiene D., Cerkauskiene R., Ubarte I., Raslanas S., Radvile E., Kaklauskaite U., Kaklauskiene L.	Emotions analysis in public spaces for urban planning
	2021	Lieven C., Lüders B., Kulus D., Thoneick R.	Enabling digital co-creation in urban planning and development
	2020	Seifert N., Mühlhaus M., Petzold F.	Urban strategy playground: Rethinking the urban planner's toolbox
	2020	Kim H.-W., Kim G.-C.	Evaluating the quality of comprehensive plans for urban resilience: The case of seven metropolitan cities in South Korea
	2019	Aguilar-Castro J.L., Díaz-Villarreal F.J., Altamiranda-Pérez J.A., Cordero J., Chavez D., Gutiérrez-De Mesa J.A.	Metropolis: An emerging serious game for the Smart City
	2019	Costa R., Machado R., Gonçalves S.	Guimarães: innovative and engaged city
	2013	Taha D.S.	The influence of social networks in visiting, planning and living in cities. Alexplore: A pilot project in Alexandria

(*continued*)

Table 1. (*continued*)

Cluster	Year	Authors	Title
Tourism	2021	Pohjola T., Gronman J., Viljanen J.	Multi-Stakeholder Engagement in Agile Service Platform Co-Creation

design. The article was crafted to examine the possibilities of improving communication between actors in the urban design process.

Datafication, in Ethical and Citizen Emancipatory Terms. Ziosi et al. propose four dimensions for Smart Cities: network infrastructure, post-political governance, social inclusion and sustainability, with data playing a crucial role. Feher examines many trend reports, white papers and research summaries to analyse the expectations of smart mentality and citizen participation. The most expected human factors are open data, communities, collective participation, socio-technical engagement, and empowerment. Marzá et al. question if the algorithmic colonisation necessitates a new structural change of public opinion or, rather, the withdrawal of this concept. Alison Paprica et al. argue that data trusts need stakeholder engagement to be established. Broomfield et al. point out that smart government needs citizen participation and interactive processes for public policies and decisions. Roberts et al. stress the importance of including practical and emancipatory knowledge interests and monitoring and evaluation tools in the project cycle. Dyakonova et al. posit that digital technologies are essential for building Smart Nations. Singh et al. suggest the usage of DL algorithms, multi-agent systems, knowledge representation and explainable AI in crowd monitoring to enable privacy-preserving and public participation.

Learning, as Algorithmic and Collective Process. Jiang et al. investigate federated learning as an approach to Smart City Sensing, a concept which may be used to address the security and privacy issues that often accompany data collection. In addition, Pournaras et al. evaluate the potential of collective learning for the development of ethical and socially responsible participatory sharing economies via the Internet of Things (IoT). Moreover, Gugerell et al. use serious gaming to improve learning processes related to stakeholder involvement and citizen engagement in urban planning and governance.

Heritage, in Terms of Cultural Heritage Protection and Enhancement. The conflict between heritage protection and urban infrastructure development rationales has created a context for inclusion, participation and dialogue among different heritage-related communities. Laužikas et al. suggest that novel technological developments with the intent to increase community involvement and democratize administrative practices, will have direct effects through technology-based participatory practices, such as 3D representation of heritage. Li proposes a development model that focuses on intangible heritage protection and encourages the participation of the entire population. Wang et al. summarise a methodology that involves creating smart data for cultural heritage, breaking through the key technologies of intelligent computing of cultural heritage, developing digital standards and platforms for cultural heritage, visualising the virtual re-appearance

of historical time and space and promoting multi-party cooperation and public participation. Jeppson et al. aim to encourage community participation and collaboration to advance the development of novel computer vision and pattern recognition technologies, allowing machine-based reconstructions of 3D objects. Flores-Ruiz et al. propose the cooperative digital platform "Les Oiseaux de Passage", which supports various European heritage communities in enhancing their cultural heritage through activities related to the tourism sector. Yu et al. apply AI to define a design process, with different levels of interaction and participation of different age groups, about intangible cultural heritage amusement spaces. Kimura et al. investigate the possibility of tourists collaborating in a new heritage preservation system based on information and communication technology, 3D restoration technology via photographic data collection and AI. Mager et al. show how the combination of crowdsourcing, historical big data and deep learning can simultaneously raise questions and provide solutions in the field of architectural and urban planning history. Crowdsourcing can offer an important opportunity for participation, incorporating their perspectives and arousing their interest in urban history and development questions.

Decision-Making Process, Including Gaming, Citizen Science and Active Participation Practices. Technology brings with it a range of advantages, yet several challenges must be dealt with, such as the processing of ever-more complex and growing data and the ethical and legal implications of AI. Governance is required to address these issues. Rindzevičiūtė furthers the participation in cultural policy, which involves engaging various stakeholders at different stages of policy-making. Purba et al. urge for increased public involvement in smart governance through collaboration, partnership, and transparency. Mallah Boustani et al. explore ways in which AI tools can improve engagement in social and political life, particularly among young people. Wilson examines 16 national strategies for AI to assess how public engagement and participation may impact the development of AI governance regimes and decision-making by public administrators. Jensen et al. use decision-making theory to explain and forecast a higher acceptance of assessment aid recommendations when perceptual cues are provided by users. The authors design and test a hybrid decision aid which performs automated linguistic analysis and elicits and analyses perceptual cues from an observer. Weng et al. use Natural Language Processing (NLP) toolkits to present a novel approach for identifying and visualising shared ideas from large-scale public consultation. Boukchina et al. employ NLP to extract valuable information from citizens' comments, applying Latent Semantic Analysis (LSA) on a corpus of comments to automatically identify the subjects addressed by citizens. Skoric et al. study how citizens' views of government control influence social media use and how this is linked to offline participation. The research suggests that social media alters the power dynamics between the government, media organisations and citizens, creating new spaces for online political discourse, which may encourage real-world political participation. Hua investigates the characteristics and differences of Internet users in urban public space governance issues. Online social media allows for free expression on urban social problems, allowing users to express their views, emotions, attitudes or opinions. Dixon et al. suggest the implementation of CRIS, a multi-modular crowdsourced Community Resiliency Information System (CRIS), as a means of creating a Holistic Smart City (HSC) which allows for scalable,

customised solutions and ensures participation from a range of communities in Smart City technology. Golini et al. propose a framework to facilitate the aggregation and classification of information related to Urban Freight Transport (UFT) in cities, called the Smart City Logistics platform. This data was used to identify intervention priorities and evaluate alternative solutions in collaboration with stakeholders. Haqbeen et al. introduce a joint research program, namely, crowd-based communicative and deliberative e-planning (CCDP), which combined an AI-driven technology, a decision-support system and experimental participatory planning. Mahmoud et al. developed a system wherein stakeholders could visualise alternative proposals through virtual reality and share collected information and results. Zhou et al. explore the potential of incorporating scenario simulations of social attributes and social interaction dimensions into the research and development of digital twin cities.

Zhou et al. propose systematic decision support for community renewal with the use of deep reinforcement learning and evolutionary game modelling to build a conceptual framework for simulation and to provide optimal solutions for AI decision support. Predescu et al. construct a serious gaming platform combining crowdsensing and Augmented Reality (AR) to boost citizen participation in smart government. Raineri et al. discuss the use of citizen science, design thinking and accountability to promote civic engagement and data-driven policy making. Shrestha et al. discuss the SWOT of integrating citizen science and spatial decision support system analysing the literature. Ramesh considers IoT and AI key elements for a smart decision-making procedure, such as smart governance, smart energy, smart building, mobility, infrastructure, technology, healthcare, and citizens. Schütz et al. present a creative intelligent user interface to appraise participatory planning and decision process submissions. This technique of citizens' participation is a form of democracy where citizens are involved in the decision-making process regarding the growth of their society. Technologies permit citizens to take part in these processes by submitting inputs via digital media such as social media platforms or dedicated websites.

Simm et al. craft "OurCity", a site-specific digital artwork intended to accumulate, sum up and represent citizens' views on the cities in which they live, diminishing the gap between citizens and policymakers. Anastasiadou et al. enrich the discussion on which technology could be suitable to which major challenge of democratic governance, amplifying the influence of information and communication technologies-enabled public governance tools for government openness, public service efficiency and user-friendliness, citizen political participation and societal mobilization. Lee et al. introduce "WeBuildAI", a collective participatory framework that allows people to construct algorithmic policy for their communities. The main notion of the framework is to enable stakeholders to create a computational model that expresses their views and to have those models vote on their behalf to form algorithmic policy. By investigating some of the most-utilized current digital technologies and displaying some of the most remarkable emerging ones, Duberry shows how active civil society organizations operate and how ICTs sustain some of their roles and, thus their participation in global environmental governance.

Art, in Terms of Vibrancy of Urban Spaces. User participation is a key indicator of the vibrancy of public spaces in cities, and examining the elements that determine a user's willingness to stay involved can help guide the design and utilization of digital

art in the ever-expanding IoT. Jiang et al. discuss how the 6G network can establish an "all-encompassing and intelligent" world based on abundant data, enabling AI implementation in diverse areas. Specifically, the authors analyse how emotional experience and media literacy can shape the likelihood of users.

Urban Planning, in Terms of Innovative Solutions able to Activate Co-creation Planning Processes. Since the mid-1900s, scientists have been exploring how to incorporate emotion into the urban planning process with qualitative methods. Kaklauskas et al. developed the "Affective System for Researching Emotions in Public Spaces for Urban Planning" (ASP System). This system combines maps data, such as observations of passers-by, climate information and air pollution levels, to help initiate citizen-centric planning solutions. Lieven et al. create an open source co-creating platform known as "DIPAS" (Digital Participation System) to get feedback from civil society. Seifert et al. propose the "Urban Strategy Playground" software framework, which uses AR to help planners develop strategies, evaluate them, and make them accessible for public participation. Kim et al. advocate for the integration of business, city planning and design and the community to achieve smart urban development. Aguilar-Castro et al. developed the city simulator game "Metropolis", which can be used by Smart Cities to make collective decisions, promote e-participation and serve as an e-decision-making tool. Costa et al. highlight how artificial intelligence, cognitive computing, and the IoT can define solutions that involve citizen engagement and participation. Finally, Taha et al. emphasize the potential of mobile social networking and geo-coding to inform decision-support systems for city planning.

Tourism, in Terms of Competitiveness and Sustainability. A systemic service platform approach and agile prototyping with smart emerging technologies such as AI, IoT, AR, 5G and Robotics, together with multi-stakeholder co-creation, as proposed by Pohjola et al., could give rise to a Smart Tourism Destination (STD), which seeks to offer strategic advantages, as well as to provide a data-driven management system to improve competitive and inclusive changes in a tourism ecosystem.

4 Discussion and Conclusions

As technology continues to become more pervasive and integrated into our everyday lives, the need to increase our participation in Artificial Intelligence (AI) is becoming more pressing. Participatory AI is a concept that emphasizes human input in the decision-making process. By leveraging the expertise of the people involved in the decision-making process, Participatory AI enables a collaborative approach to decision-making, where decisions are based on the collective insight and experience of the stakeholders. Involving stakeholders in the decision-making process means not only providing their participation but also increasing their understanding of the entire process, pros and cons related to the use of AI.

This degree of awareness allows them to be more likely to feel connected to the process and more likely to use the outcome. This can lead to satisfaction and loyalty, which can positively impact the outcomes of an urban decision-making process. This paper contributes to clarifying the opportunities given by the interaction between AI and

stakeholders, giving a general literature review of methods adopted to encourage citizen participation.

Augmented Reality, Data Visualization, Interfaces, Digital Twins, and Evolutionary Games are such tools explored in this contribution, useful to engage general citizens in scientific research, thereby empowering them to participate in the decisions of the issues affecting them. The reconstruction of the scientific landscape around the fundamental concepts of "AI" and "stakeholder engagement", integrating the literature review with analysis of bibliometric maps, aimed to define a general framework to explore the role of citizen participation in urban decision-making processes using ai tools to deal with the future challenges. From this framework, the research intends to investigate the opportunities given using different types of AI in Smart Cities to encourage citizen participation as a key element of smart development, defining a new form of social engagement in a smart context.

Author Contributions. Conceptualization, M.C., F.D.M., S.S.; methodology, M.C., F.D.M., S.S.; validation, M.C. and F.D.M.; formal analysis, S.S.; investigation, S.S.; writing-original draft preparation, S.S.; writing-review and editing, M.C., F.D.M., S.S.; visualization, S.S.; supervision, M.C. and F.D.M. All authors have read and agreed to the published version of the manuscript.

References

1. Hollands, R.G.: Will the real smart city please stand up? City **12**(3), 303–320 (2008)
2. Washburn, D., Sindhu, U., Balaouras, S., Dines, R.A., Hayes, N.M., Nelson, L.E.: Helping CIOs Understand "Smart City" Initiatives: Defining the Smart City, its Drivers, and the Role of the CIO. Forrester Research Inc, Cambridge (2010)
3. Su, K., Li, J., Fu, H.: Smart city and the applications. In: Proceedings of IEEE International Conference on Electronics, Communications and Control (ICECC), pp. 1028–1031. Institute of Electrical and Electronics Engineers (IEEE), Ningbo (2011)
4. Mitton, N., Papavassiliou, S., Puliafito, A., Trivedi, K.: Combining Cloud and sensors in a smart city environment. EURASIP J. Wirel. Commun. Networking, 1–10 (2012)
5. Yin, C., Xiong, Z., Chen, H., Wang, J., Cooper, D., David, B.: A literature survey on smart cities. Sci. China Inf. Sci. **58**(10), 1–18 (2015). https://doi.org/10.1007/s11432-015-5397-4
6. Harrison, C., Eckman, B., Hamilton, R., Hartswick, P.: Foundations for smarter cities. IBM J. Res. Dev. **54**, 1–16 (2010)
7. Nam, T., Pardo, T.A.: Conceptualizing Smart City with dimensions of technology, people, and institutions. In: Proceedings of the 12th Annual International Digital Government Research, pp. 282–291. Association for Computing Machinery, College Park (2011)
8. Creating "the smart city". Rios, Patrice. https://archive.udmercy.edu/handle/10429/393. Accessed 14 May 2023
9. Cavoukian, A., Chibba, M.: Cognitive cities, big data and citizen participation: the essentials of privacy and security. In: Portmann, E., Finger, M. (eds.) Towards Cognitive Cities. SSDC, vol. 63, pp. 61–82. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-33798-2_4
10. Mostashari, A., Arnold, F., Mansouri, M., Finger, M.: Cognitive cities and intelligent urban governance. Netw. Ind. Q. **13**(3) (2011)
11. Moyser, R., Uffer, S.: Cognitive Cities, From smart to cognitive: a roadmap for the adoption of technology in cities. In: Portmann, E., Finger, M. (eds.) Towards Cognitive Cities: Advances in Cognitive Computing and Its Application to the Governance of Large Urban Systems, pp. 61–82. Springer, Heidelberg (2016). https://doi.org/10.1007/978-3-319-33798-2_2

12. Kim, H.M., Sabri, S., Kent, A.: Smart Cities for Technological and Social Innovation, 1st edn. Academic Press (2020)
13. Partridge, H.: Developing a human perspective to the digital divide in the smart city. In: Proceedings of the Biennial Conference of Australian Library and information Association, Australia (2004)
14. Castro-Arce, K., Parra, C., Vanclay, F.: Social innovation, sustainability and the governance of protected areas: revealing theory as it plays out in practice in Costa Rica. J. Environ. Plan. Manag. **62**, 2255–2272 (2019)
15. Ellen MacArthur Foundation, Cities in the circular economy: an initial exploration. Available at https://www.ellenmacarthurfoundation.org/. Accessed 14 May 2023
16. Poli, G., Muccio, E., Cerreta, M.: Circular, cultural and creative city index: a comparison of indicators-based methods with a machine-learning approach. Aestimum **81** (2022)
17. Bosone, M., De Toro, P., Fusco Girard, L., Gravagnuolo, A., Iodice, S.: Indicators for ex-post evaluation of cultural heritage adaptive reuse impacts in the perspective of the circular economy. Sustainability **13**(9), 4759 (2021)
18. Sacco, S., Cerreta, M.: A decision-making process for circular development of city-port ecosystem: the East Naples case study. In: Gervasi, O., Murgante, B., Misra, S., Rocha, A.M.A.C., Garau, C. (eds.) Computational Science and Its Applications – ICCSA 2022 Workshops. ICCSA 2022. LNCS, vol. 13378. Springer, Cham (2022). https://doi.org/10.1007/978-3-031-10562-3_40
19. United Nations: Resolution adopted by the General Assembly on 6 July 2017, A/RES/71/313. https://unstats.un.org/sdgs/. Accessed 14 May 2023
20. Cardone, B., Di Martino, F.: A GIS-based fuzzy multiclassification framework applied for spatiotemporal analysis of phenomena in urban contexts. Information, Special Issue on Knowledge (2022)
21. Cardone, B., Di Martino, F., Senatore, S.: A fuzzy partition-based method to classify social messages assessing their emotional relevance. Inf. Sci. **594**, 60–75 (2022)
22. Cardone, B., Di Martino, F.: Fuzzy-based spatiotemporal hot spot intensity and propagation - an application in crime analysis. Electronics **11**(3), 370 (2022)
23. Cardone, B., Di Martino, F.: GIS-based hierarchical fuzzy multicriteria decision-making method for urban planning. J. Ambient. Intell. Humaniz. Comput. **12**(1), 601–615 (2020). https://doi.org/10.1007/s12652-020-02043-6
24. Birhane, A., et al.: Power to the people? Opportunities and challenges for participatory AI. In: Equity and Access in Algorithms, Mechanisms, and Optimization. EAAMO 2022, Article 6, pp. 1–8. Association for Computing Machinery, New York (2022)
25. Van Eck, N.J., Waltman, L.: Accuracy of citation data in Web of Science and Scopus. arXiv preprint arXiv:1906.07011 (2019)
26. Van Eck, N.J., Waltman, L.: Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics **84**(2), 523–538 (2010). https://doi.org/10.1007/s11192-009-0146-3
27. Van Eck, N.J., Waltman, L.: VOSviewer Manual, vol. 1, no. 1, pp. 1–53. Univeristeit Leiden, Leiden (2013)