Smart City and Immersive Art Projects: a Bibliometric Analysis*

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Abstract

This research aims to identify publications that form knowledge about modern ICT for creating immersive art projects. The analysis shows that immersive technologies change the urban experience due to interactive public art installations. Immersive art projects become iconic and symbolic elements of the smart city ecosystems. A bibliometric analysis of publications available in Scopus on immersive art projects for smart cities was carried out. As a result of the screening, 217 documents were selected for subsequent bibliometric analysis. It was found that the chosen documents belong to 20 areas of knowledge, which are grouped into technical, social, natural, formal, humanities, medicine and health care, and multidisciplinary. The content analysis of publications made it possible to identify documents related to immersive art projects in each branch of knowledge. It was found that documents already exist that present the results of immersive art projects implemented in cities such as Athens, Cardiff, Tokyo, Rome, Seoul, Qingdao, Bagerhat, and others. The selected documents are structured by type, research geography, and authors' affiliation. A "cloud" (using WordItOut) and a "diagram" (using MS Excel) were generated to visualize the frequency of keyword usage. It allowed us to establish the underrepresentation of "Immersive/Immersion, Immers Technology/Immersive Technologies, Immersive Virtual Reality, Immersive Experience" in scientific research on the smart city environment.

Keywords of publications on "Smart City. Immersive" were structured by clusters, and bibliometric maps were developed using VOSviewer software. Five items described are: 1 – Immersive technologies for smart urban growth; 2 – Smart city development based on extended reality; 3 – Extended reality for sustainable smart cities; 4 – Intelligent digital ecosystems; and 5 – Urban development and growth.

The findings may be the basis for further research to analyze the impact of immersive art projects on the sustainable development of smart cities.

Keywords

smart sustainable cities, information and communication technologies (ICT), immersive art project, bibliometric analysis, Scopus, bibliometric data, bibliometric map, urban development, intelligent environment, extended reality (XR)

1. Introduction

Smart technologies are widely used for planning, maintaining, and managing cities. All over the world, investors, city leaders, and ordinary citizens are paying increasing attention to the results of integrating digital technologies into urban infrastructure. Global rankings are compiled to assess the state of a smart city (Smart City Index, Smart City Maturity, Cities in Motion Ranking, Smart City Index Master Indicators, European Smart Cities Ranking, etc.), and their indicators serve as the basis for further development and implementation of smart tools, as well as planning relevant projects,

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programs, and strategies [1–3]. The number of scientific publications on Smart City and interest in the development of the concept has also been growing over the past 10 years [4].

At the heart of a smart city is integrating information and communication technologies (ICT) to expand and improve urban infrastructure and the environment. The “smartness” of cities is not only about digital technologies “tied to documents”, installing digital interfaces in traditional infrastructure, or optimizing the city's work, but also the purposeful use of technology and data to make better decisions and ensure a better quality of life. Municipalities, urban planners, engineers, and architects are collaboratively leveraging new-age digital technologies to create smart development strategies a reality [5, 6]. Big data, artificial intelligence, the Internet of Things, and the cloud are just some of the technologies that can contribute to the success of city initiatives. The hallmark of a smart city is its focus on people first and foremost, satisfying their needs [7–9].

A smart city is an expression of technology as a socio-technical system. A smart city as an urban environment is assessed in terms of the application of ICT to increase the benefits and reduce the disadvantages of urbanization for its residents. Accordingly, the city’s information and communication infrastructure and digital urban technologies (city portals for online information services) should be “tied to people” not just digitalizing documents [10–12]. In addition, the modern vision of a smart city includes a deep fusion of many different technical systems into a single integrated “intelligent environment” [13]. Smart technologies immerse users in a virtual environment (including virtual reality (VR), augmented reality (AR), and mixed reality (MR), digital media) and integrate them with the natural world to provide sensory stimulation, such as visual, auditory, and tactile, resulting in a simulation of the real world and providing users with an immersive experience [14].

Augmented and virtual reality have a huge potential to transform and revolutionize the way of life of city dwellers, in particular, to provide users with a new and safe experience of navigating the city. Immersive technologies are aesthetically changing urban everyday life, offering new forms of sensory experience in urban public space. Smart cities use public art installations (interactive digital artworks) to create beautiful (aesthetically appealing) public spaces. Immersive art projects in public spaces also have the potential to foster innovation. Immersive art projects in public spaces are also seen as a factor in improving the psychological well-being of urban residents [15, 16]. Digital art, placed in the public urban landscape, is more than just a “feel good factor” as it can foster innovation and become a significant component of a smart city's creative infrastructure and creative economy [17]. Smart cities use digital platforms to provide opportunities for artistic expression and community engagement. This can include virtual exhibitions, online galleries, and digital art initiatives that allow artists to showcase their work to a broader audience. By creating a conducive ecosystem for creativity and entrepreneurship, smart cities attract and retain talent, stimulate innovation, and foster the development of cultural and arts industries [18].

Digital art museums are becoming attractive “tourist magnets”. For example, TeamLab Borderless Digital Art Gallery (Tokyo, Japan) had more than 2 million visitors from over 160 countries in its first year of operation (2018), making it the most visited museum in the world [19]. Atelier des Lumières (Paris, France) had over a million visitors in its first year of operation (2018) [20]. Frameless (London, UK), the largest permanent multi-sensory center in the UK, exhibits several immersive art projects, with “Van Gogh: The Starry Night” being the most popular among visitors [21]. Ars Electronica Center (Linz, Austria) is an important international center for media-sensory art projects [22]. In 2023, Melt Museum, one of the first immersive art centers in Central and Eastern Europe, opened in Warsaw (Poland) [23]. Digital artworks are also placed in public places on large screens or media facades and become part of the city's urban infrastructure, and just like museums with immersive exhibitions, symbolize the city's

Figure 1: Media facade of the shopping center with the multisensory exhibition “Immersive World of Taras Shevchenko” (2023, Kyiv, Ukraine). Photo [25].

smartness [17]. Figure 1 shows a photo of a multimedia demonstration of the exhibition “Immersive Shevchenko: Soul of Ukraine” [24] on the media facade of a shopping mall in Kyiv.

Around the world, there is a significant increase in the popularity of this fascinating art. According to Glimpse, a consumer behavior analysis platform, the number of searches for the term “immersive art” increased by 22% in the first three months of 2025 worldwide. However, art is sometimes ignored in discussions about the “smart future” of urban environments, although smart city technologies without an artistic and cultural component provide one-sided development. Similarly, aspects of creativity and art are poorly represented in existing smart city indices [26]. Against this background, there is a need to highlight the extent to which the topic of immersive art in the smart city space is represented in scientific publications. Existing bibliometric studies of smart cities do not mention this topic [4, 27–30]. On the other hand, bibliometric studies of immersive art projects [4, 16, 29–32] do not correlate with the smart city. A review of publications on bibliometric studies of smart cities and immersive art projects allowed us to outline the objectives of this study.

2. Purpose and objectives of the research

This research aims to identify publications that form knowledge about modern ICT for creating immersive art projects.

To achieve this goal, the following tasks were formulated:

- to search for publications that highlight the possibilities and results of using ICT to create immersive projects;
- to analyze publications published in the Scopus scientific and metric database using visualization tools;
- to develop bibliographic maps of keywords using VosViewer Software.

3. Bibliometric analysis of research related to the implementation of immersive art projects in smart cities

Bibliometrics is a valuable methodology for quantitative research. It uses statistical and quantitative data to shed light on publication patterns in a particular field of knowledge. The usefulness of bibliometric analysis lies in the ability to reflect the state and development of research topics over time. The epistemological potential of bibliometric analysis lies in its ability to reflect the development of research disciplines over time. Bibliometric analysis also helps identify relationships between authors' research interests, academic institutions, and the most influential (cited) studies in a particular field of knowledge. In addition, bibliometrics can be used to form research teams and predict new research trends.

3.1. Data collection methodology

The scientometric database Scopus was used to select the documents. The database search was in the “Article title, Abstract, Keywords” field with “smart AND city AND immersive”. The “time period” included all publications from when the first document was created until April 13, 2025.

The “Subject Area” field showed that the context of the selected documents falls within 20 areas of knowledge (Figure 2). The most significant number (169 documents) refers to Computer Science. For subsequent analysis, the 20 areas of knowledge were grouped into branches of knowledge:

- technical (Computer Science, Engineering) – 192 documents;
- social (Social Sciences, Business, Management and Accounting, Economics, Econometrics and Finance) – 63 documents;
- natural (Physics and Astronomy, Chemistry, Biochemistry, Genetics and Molecular Biology, Earth and Planetary Sciences, Materials Science, Agricultural and Biological Sciences, Environmental Science, Energy) – 49 documents;
- formal (Mathematics, Decision Sciences) – 54 documents;
- humanities (Arts and Humanities) – 8 documents;
- medicine and health care (Medicine, Neuroscience, Health Professions) – 7 documents;
- multidisciplinary – 2 documents.

By applying content analysis, it was revealed that the topics of immersive art projects are covered in all branches of knowledge, which are: technical – [26], [33], [34], [35]; social – [33], [34], [36], [37]; natural – [33], [38]; formal – [35], [39]; humanities – [34], [40]; medicine and health care – [33], [37]; multidisciplinary – [41], [42]. In this case, it was revealed that the Scopus database identifies some documents about immersive art projects in several branches of knowledge, including:

- a conference paper on applying metauniverse technology to showcase cities (a virtual exhibition hall that integrates avatars and intelligent Non-Player Characters) and evaluating immersive user experience [33] – four branches of knowledge (technical, natural, social, and medical);
- an article on the project of immersive VR/AR visualization of ancient cultural heritage in Rome [34] – three branches of knowledge (technical, social, and humanities);
- a conference paper presents a multisensory interactive installation art project employing ubiquitous computing technologies for creatively translating the urban data of Athens [35] – two branches of knowledge (technical and formal);

- a book chapter on applying IoT technology, QR & Mobile Apps and Gamification in tourism (in religious places) providing immersive experience for users [37] – two branches of knowledge (social and medical);
- a conference paper on applying handheld devices that can feed seamless, authentic information and augmented visualization to the immersive tour at the ancient heritage of Khalifatabad (in Bangladesh) [43] – two branches of knowledge (technical and medical).

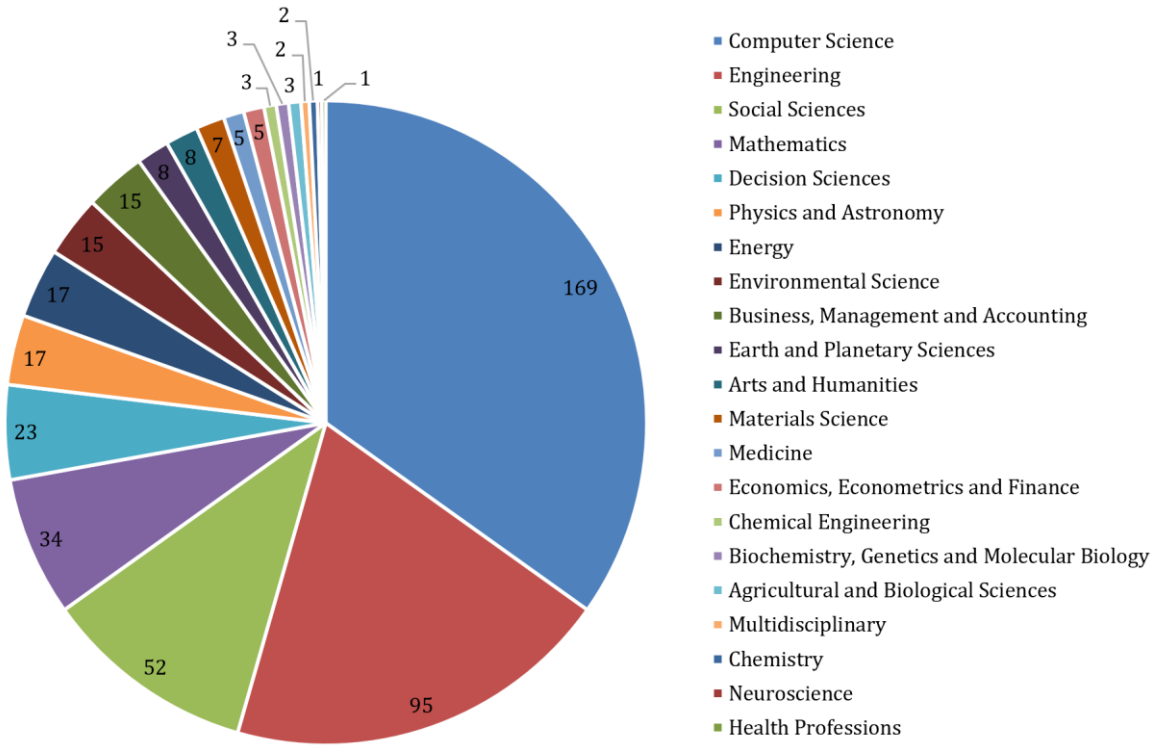


Figure 2: Representativeness of publications in the subject areas selected by the query "smart AND city AND immersive" in the Scopus scientometric database.

Immersive art projects in smart cities are covered in branches of knowledge in different dimensions and aspects. For example, among the 49 documents selected for the natural branch of knowledge, there is an article about a virtual planning support theatre for city planning and policy making [38]. Among the documents selected for the technical branch of knowledge, a conference poster [44] presents a novel application of extended reality (XR) to advance smart city initiatives and Immersive Cultural Heritage Tourism in Seoul. The technical branch of knowledge also includes a conference paper on the plant of the PALM-Cities project, installed at a modern art museum in Genoa, which offers visitors to the exhibition an immersive experience [26]. Conference paper [36], included in the social branch of knowledge, presents a systematic review on the use of IoT-escape room type of games in museums or other cultural places that can provide an immerse visitors in a cultural/historic environment as active users. In selected documents in the formal branch of knowledge, there is a conference paper [39] centers around XR technology (a marine XR show), integrating actual city maritime scenery in Qingdao (China), with augmented reality. In selected documents in the humanities branch of knowledge, there is an article that analyzes the interactive digital platforms (transmedia Memory Projects) and art installations of a smart city (Singapore), allowing players to internalize the knowledge of the city's history through immersive spatialization of mobile video games.

The article analyses an ambitious interactive public art project embedding SMART technology on the coastal fringes of Cardiff, the capital city of Wales (UK), including delivering a stimulating aesthetic experience in and on a complex site, for a complex audience profile.

The article [40], also selected to the humanities branch of knowledge, analyzes an ambitious interactive public art project with the implementation of SMART technology on the seafront of Cardiff, the capital of Wales (UK), including the provision of a stimulating aesthetic experience in a complex place and a complex location for a complex audience profile.

The multidisciplinary branch of knowledge is represented by two articles, both related to immersive art projects. The article [41] examines how a convolutional neural network (CNN) is used in the immersive world of digital media art; it explains digital media art in the context of smart cities and the use of immersive scenarios. The article [42] focuses on applying human-computer interaction VR technology in urban cultural creative design; it designed an immersive urban design simulation platform.

The "Document type" field shows that the selected documents are structured as follows: conference paper – 88, article, – 65, conference review – 24, book chapter – 19, review – 14, book – 4, editorial – 2, short survey – 1. As a result of the screening, all documents (217) were selected for further analysis, except for two (1 – erratum and 1 – retracted). According to the "Country/territory" field, the authors of the documents represent 57 countries: China (36 documents), United States (27 documents), India (27 documents), Italy (22 documents), Australia (15 documents), United Kingdom (13 documents), Spain (12 documents), South Korea (10 documents) ets., and 26 documents – "undefined".

3.2. Top-level analysis of bibliometric data

The analysis demonstrates the priority of the source in which the selected documents are published, namely: Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics (7 documents); Lecture Notes in Networks and Systems (6 documents); Future Internet (5 documents); Sustainability Switzerland (4 documents); Smart Innovation Systems and Technologies (4 documents); Lecture Notes of the Institute for Computer Sciences Social Informatics and Telecommunications Engineering Lnicst (4 documents); Communications in Computer and Information Science (4 documents); ACM International Conference Proceeding Series (4 documents). The most-cited are six documents in such Source titles: in Engineering Applications of Artificial Intelligence [45] – 366 citations), in Land Use Policy [46] – 196 citations), in IEEE Communications Surveys and Tutorials [47] – 142 citations, in IEEE Internet of Things Journal [48] – 118 citations, in Internet of Things [49] – 104 citations, Computational Urban Science [50] – 101 citations.

In terms of research geography, the authors of the documents are affiliated with 158 organizations, most of which are scientific and academic institutions (124), and 34 are other organizations such as Google LLC, Huawei France Research Center, NASA Ames, Insight (Science Foundation Ireland (SFI) research center for Data Analytics, Ireland), Engineering Ingegneria Informatica S.p.A. (an Italian company in the IT software and services sector), RAI – Radiotelevisione Italiana (the national public broadcaster of Italy, owned by the Ministry of Economy and Finance), National Central Library of Florence (Italy), Darts Engineering (an Italian company in the IT software and services sector), Open Geospatial Consortium (an international non-profit organization engaged in the development of standards in the field of geospatial data and services, UK), ets. The affiliation of these institutions is confirmed by a different number of documents (from 1 to 4). Two universities have 4 documents each (Deakin University, Australia; Dublin City University, Ireland), nine institutions have 3 documents each: Università degli Studi di Salerno (Italy); Queensland University of Technology (Australia); Norges Teknisk-Naturvitenskapelige Universitet (Norway); Oregon State University

((United States, U.S); University of Greenwich (United Kingdom, UK); Università degli Studi della Campania Luigi Vanvitelli (Italy); Alma Mater Studiorum Università di Bologna (Italy); UNSW Sydney (Australia); Zayed University. (United Arab Emirates, UAE).

A significant element of bibliometric analysis is the frequency of keywords used. 160 keywords were filtered out of 217 documents. The following were excluded for further analysis:]+ Catalyst, Antennas, 'current, Students, Systematic Review. Along with that, keywords that are similar in meaning were grouped together: Smart City/Smart Cities (in 119 documents); Virtual Reality/Virtual Reality (VR)/VR (in 78 documents); Augmented Reality/Augmented Reality (AR)/AR (in 53 documents); Metaverses/Metaverse (in 48 documents); Internet of Things/ Internet of Things (IoT)/IoT (in 46 documents); Immersive/Immersion (in 44 documents); Blockchain/Block-chain (in 20 documents); Digital Twin/Digital Twins (in 20 documents); Sustainable City/Sustainability/Sustainable Development (in 19 documents); 3D Visualization/3D Models/3D Modeling/3d-modeling/ Three Dimensional Computer Graphics (in 16 documents); User Experience/Users' Experiences (in 14 documents); Education/E-learning (in 13 documents); Immersive Technology/Immersive Technologies (in 13 documents); Human Computer Interaction/Humaninteraction (in 12 documents); Mobile Computing/Mobile Edge Computing (in 8 documents); Smart Campus/Smart Home (in 7 documents); Avatar/Avatars (in 6 documents); Co-creation/ Co-design (in 5 documents); Cloud Computing/Cloud-computing (in 4 documents).

A keyword cloud was generated using the web tool WordItOut (Figure 3). The keyword frequency diagram is presented in Figure 4. Such tools as “cloud” and ‘diagram’ visualize the meaningfulness of terms in relation to “Smart City. Immersive” based on the number of mentions in the analyzed documents. The I-terms (Immersive/Immersion, Immersive Technology/Immersive Technologies, Immersive Virtual Reality, Immersive Experience) are visually impaired, reflecting the small number of existing studies and insufficient scientific representation of the relevant issues.

Figure 3: Keywords cloud in the documents on “Smart City. Immersive” in Scopus (generated by WordItOut).

3.3. Bibliometric maps and keyword cluster analysis

The bibliometric analysis of the data was conducted using the VOSviewer software version 1.6.20. To export data on the selected 217 documents from the Scopus database in CSV format, the following settings were chosen:

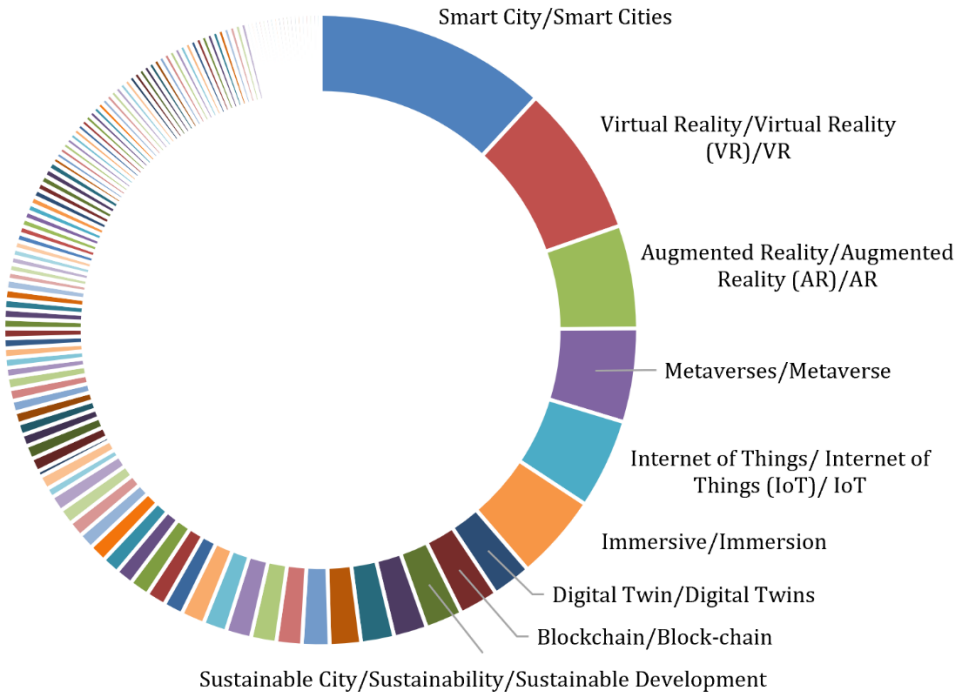


Figure 4: Diagram of the frequency of keywords in the documents on "Smart City. Immersive" in Scopus (using MS Excel)

- Citation information (Author(s), Document title, Year, EID, Source title, Volume, issues, pages, Citation count, Source & document type, Publication stage, DOI, Open access);
- Bibliographical information (Affiliations, Serial identifiers (e.g. ISSN), PubMed ID, Publisher, Editor(s), Language of original document, Correspondence address, Abbreviated source title);
- Abstract & keywords (Abstract, Author keywords, Indexed keywords);
- Funding details (Number, Acronym, Sponsor, Funding text);
- Other information (Tradenames & manufacturers, Accession numbers & chemicals, Conference information, Include references).

To create a map based on bibliographic data, the following parameters are set in the VOSviewer program: Type of analysis – Co-occurrence; Unit of analysis – All keywords; Counting method – Full counting; Minimum number of occurrences of a keyword – 5, and 3 keywords (Antennas, 'current, Students) are excluded. As a result of screening, the VOSviewer program selected 51 keywords and for each word calculated the number of occurrences and the total strength of the co-occurrence links with keywords. The co-word analysis revealed that the most frequently used keyword was “smart city”, with 79 occurrences, followed by “virtual reality” (70 occurrences), “augmented reality” (47 occurrences), and «Immersive» (41 occurrences, 211 links). Table 1 displays the top 10 co-occurring keywords.

The bibliometric map (Figure 5) contains 51 keywords structured into five clusters, including “Immersive Virtual Reality” (in Cluster 1), “Immersive” (in Cluster 2), and “Immersive Technologies” (in Cluster 3):

- Claster 1 (red) – 18 items (3D Reconstruction, Big Data, Data Visualization, Decision Making, Engineering Education, Helmet Mounted Displays, Human Computer Interaction, **Immersive Virtual Reality**, Mixed Reality, Simulation, Three Dimensional Computer Graphics, Urban Environments, Urban Planning, User Interfaces, Virtual Environments, Virtual Reality, Virtual Reality Technology, Visualization);

Table 1
The 10 most frequent keywords in the keyword co-occurrence analysis

Rank	Keyword	Occurrence	Total link strength
1	Smart City / Smart Cities	119	526
2	Virtual Reality	70	310
3	Augmented Reality	47	225
4	Immersive	41	211
5	Metaverses/Metaverse	48	289
6	Internet of Things/IoT	43	195
7	Blockchain/ Block-chain	20	126
8	Digital Twin/ Digital Twins	20	117
9	Mixed Reality	17	102
10	Artificial Intelligence	17	80

- Claster 2 (green) – 14 items (5G Mobile Communication Systems, Augmented Reality, E-Learning, Edge Computing, **Immersive**, Information and Communication Technologies, Internet of Things, IoT, Mobile Applications, Mobile Edge Computing, Smart City, Tourism, User Experience, Virtual Worlds);
- Claster 3 (blue) – 10 items (Digital Devices, Digital Twins, Education, Energy Efficiency, Extended Reality, **Immersive Technologies**, Real-World, Smart Cities, Sustainability, Sustainable Development);
- Claster 4 (mustard) – 7 items (Artificial Intelligence, Blockchain/Block-Chain, Digital Twin, Metaverse/Metaverses, Mobile Communications);
- Claster 5 (violet) – 2 items (Urban Development, Urban Growth).

On the bibliometric map (Figure 5), 610 links are marked between 51 items, total link strength – 1669.

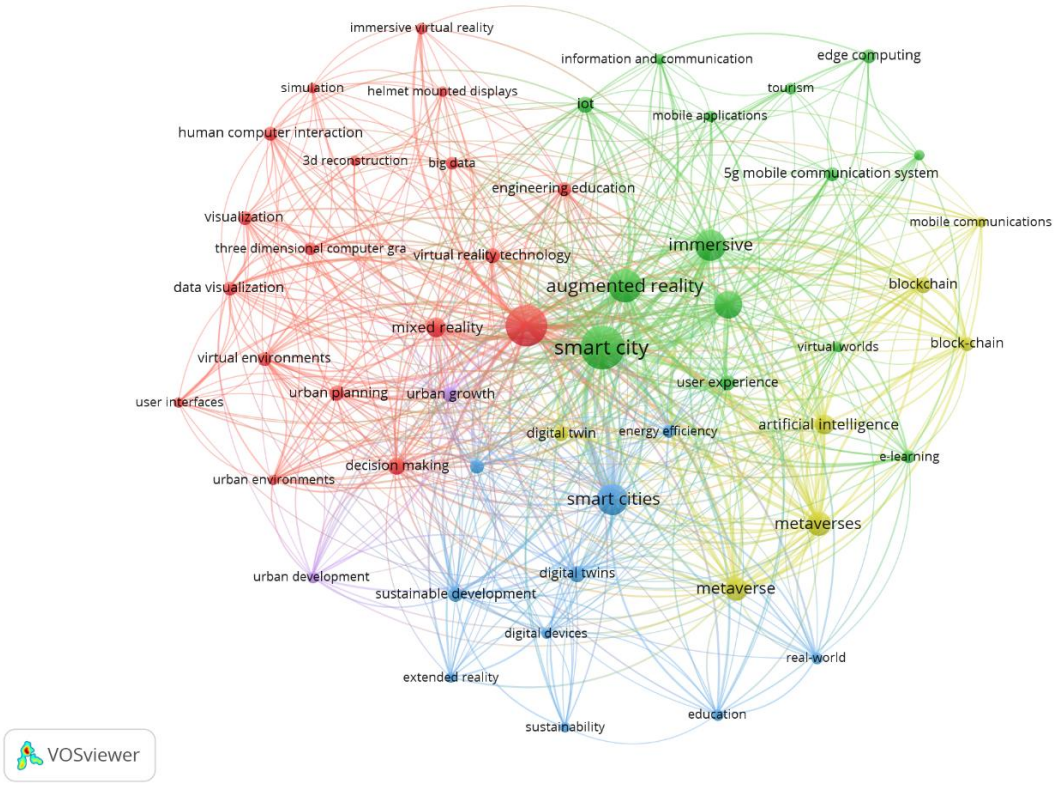


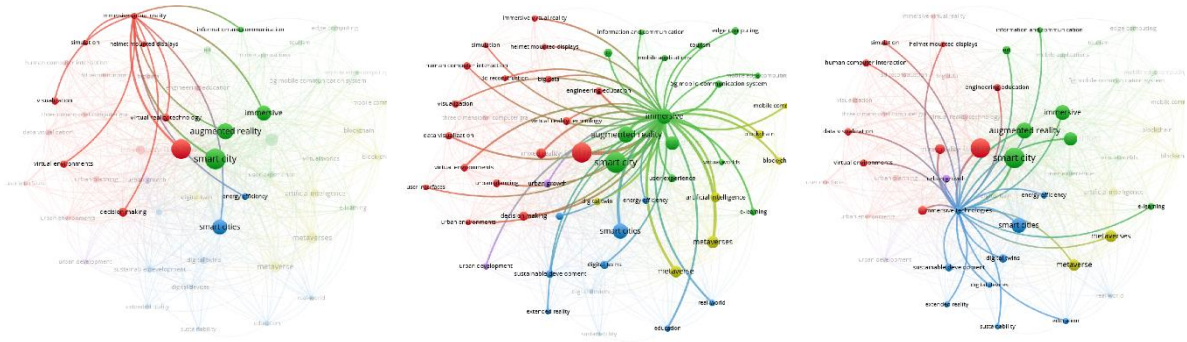
Figure 5: Bibliometric map of keyword clusters (items) in documents on “Smart City. Immersive” in Scopus

A cluster analysis of keywords (items) showed that:

- Cluster 1 represents a conceptual field of knowledge and forms the basis for creating interactive, visually rich environments that contribute to making informed decisions, analyzing complex structures (in particular, cities), improving education, and developing new formats of interaction with information in real and virtual spaces;
- Cluster 2 creates a synergy of telecommunications, mobility, intelligent environments and human-centric design aimed at developing digital ecosystems of the future of cities;
- Cluster 3 reflects the integration of digital solutions to create a sustainable future, in which smart city infrastructure, education, and eco-awareness develop in interconnection;
- Cluster 4 unites technologies that create an interconnected digital reality, in which the boundaries between physical and virtual, centralized and decentralized, local and global disappear;
- Cluster 5 includes current approaches to urban development based on innovation, balance of infrastructure, ecology, and social environment.

Applying the “Keywords” filter in Scopus allowed the selection of documents related to each cluster. Table 2 demonstrates the documents with the largest citations for each cluster.

The analysis of the links between the keywords “Immersive” – “Immersive virtual reality” – “Immersive Technology” (Figure 6) showed that the lack of connection between immersive technologies and immersive virtual reality on the bibliometric map is an “epistemic gap”. Considering that smart cities are focused on creating an integrated environment, it can be assumed that such a link is not yet sufficiently articulated at the scientific research level and is not represented by publications in Scopus.



a *b* *c*

Figure 6: Bibliometric map of keywords: a – “Immersive Virtual Reality”, b – “Immersive”, c –“Immersive Technologies”

Figure 7 presents a map of clusters of keywords (items) of documents related to “Smart City. Immersive” in time (by year). Notably, that by 2020, the documents mostly used the items included in Cluster 1 (Human Computer Interaction, Big Data, 3D Reconstruction, Three Dimensional Computer Graphics, User Interfaces, Data Visualization) and Cluster 2 (Mobile Applications, User Experience). Over the past three years (2023–2025), documents that contain items from all clusters became dominant, namely: Virtual Environments (Cluster 1); Mobile Edge Computing (Cluster 2); Sustainable Development, Extended Reality, Digital Devices, Sustainability (Cluster 3); Metaverse/Metaverses, Artificial Intelligence, Blockchain/Block-Chain, Mobile Communications (Cluster 4); Urban Development (Cluster 5).

Table 2

Structuring of keywords (items) in documents related to “Smart City. Immersive” in Scopus

Cluster name	Keywords (items)	Cluster Description	Most cited documents
Cluster 1. Immersive Technologies for Smart Urban Growth	**Data Visualization,** Three Dimensional Computer Graphics, Visualization, **Human Computer Interaction**, User Interfaces, Helmet Mounted Displays, Decision Making, **Virtual Reality,** Virtual Environments, Immersive Virtual Reality, Virtual Reality Technology, Mixed Reality, **Urban Environments**, Urban Planning, Simulation, 3D Reconstruction, Engineering Education, Big Data	The cluster brings together interdisciplinary concepts related to developing and using virtual, visualization, and simulation technologies for modeling complex systems, analyzing big data, and human interaction with the digital environment	[45] – 366 citations, [48] – 118 citations, [51] – 97 citations, [52] – 94 citations, [53] – 76 citations, [27] – 72 citations, [54] – 69 citations, [55] – 58 citations.
Cluster 2. Smart city	**5G Mobile Communication Systems**, Edge Computing,	The cluster brings together modern information and	[45] – 366 citations, [46] – 196 citations,

development based on Extended Reality	Mobile Edge Computing, Information and Communication Technologies, Internet of Things (IoT), **Mobile Applications**, User Experience, E-Learning, Tourism, **Augmented Reality**, Immersive, Virtual Worlds, **Smart City**	communication technologies, immersive digital environments and application services that transform user interaction with information, space, and technologies	[47] – 142 citations, [48] – 118 citations, [49] – 104 citations, [51] – 97 citations, [56] – 96 citations.
Cluster 3. Extended Reality for Sustainable Smart Cities	**Sustainability**, Sustainable Development, Energy Efficiency, **Smart Cities**, Digital Twins, Real-World, Digital Devices, **Immersive Technologies**, Extended Reality, Education,	The cluster brings together current digital technologies (digital devices, digital twins, and immersive technologies) to develop sustainable, innovative, and educationally oriented urban environments	[46] – 196 citations, [48] – 118 citations, [49] – 104 citations, [56] – 96 citations.
Cluster 4. Intelligent Digital Ecosystems	**Artificial Intelligence**, **Blockchain/**Block-Chain, Mobile Communications, **Digital Twin/ Digital Twins**, Metaverse/Metaverses	The cluster covers key next-generation digital technologies that form the foundation of future virtual, decentralized, and mobile digital ecosystems	[45] – 366 citations, [46] – 196 citations, [47] – 142 citations.
Cluster 5. Urban Development and Growth	**Urban Development**, Urban Growth	The cluster encompasses current approaches to urban planning, including innovative models of urban development, principles of sustainable development	[46] – 196 citations.

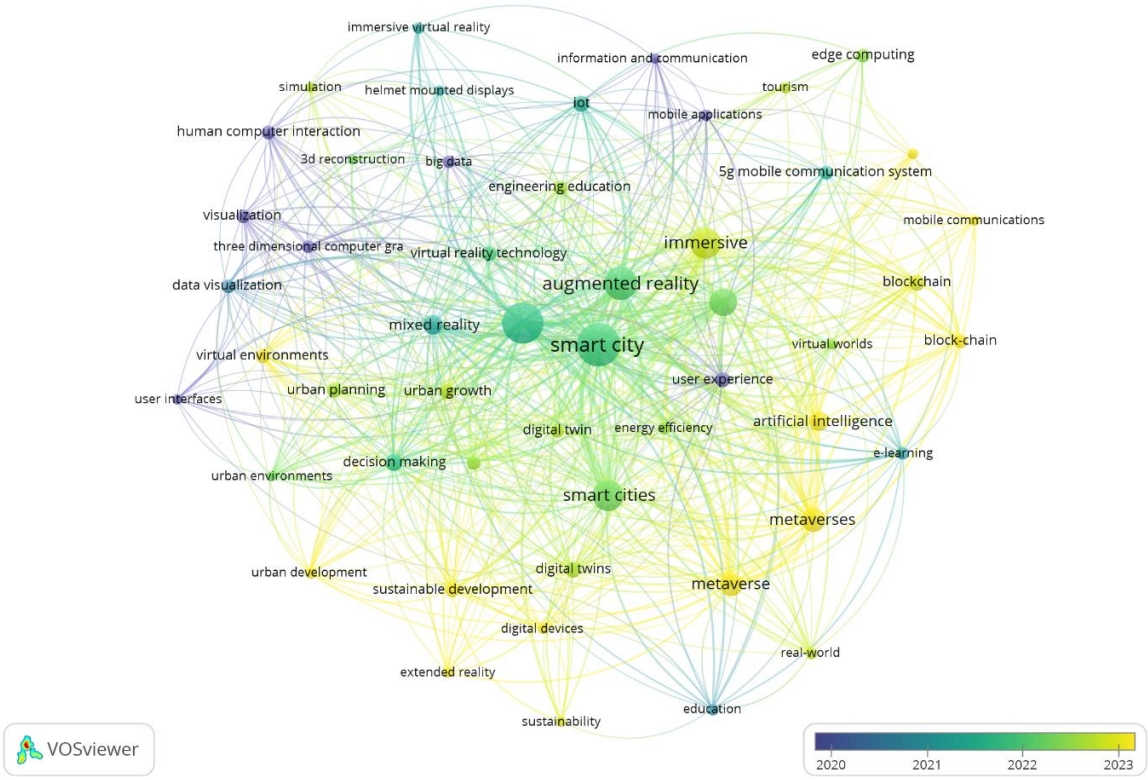


Figure 7: Bibliometric map of clusters of keywords (items) of documents on “Smart City. Immersive” in Scopus over time (by year)

4. Conclusions

The analysis showcases that a smart city envisions a deep fusion of different technologies (including VR, AR, MR, and XR) and a shared intelligent environment where residents and visitors can have an immersive experience. Immersive technologies change the urban experience due to interactive public art installations beautifying the space and promoting residents' innovation and psychological well-being. Immersive art projects become iconic and symbolic elements of the smart city ecosystems.

A bibliometric analysis of publications available in Scopus on immersive art projects for smart cities was carried out. It included preparing data for selection through the query “smart AND city AND immersive” in the “Article title, Abstract, Keywords” field. As a result of the screening, 217 documents (published before April 13, 2025) were selected for subsequent bibliometric analysis. It was found that the chosen documents belong to 20 areas of knowledge, most of which are related to Computer Science (169 documents). Twenty fields of knowledge were grouped into branches of knowledge: technical, social, natural, formal, humanities, medicine and health care, and multidisciplinary. The content analysis of publications made it possible to identify documents related to immersive art projects in each branch of knowledge. It was also found that the Scopus database identifies some documents about immersive art projects in several areas of knowledge. However, the topic of immersive art in smart cities is presented in different aspects of the knowledge branch. The documents present the results of immersive art projects implemented in cities such as Athens, Cardiff, Tokyo, Rome, Seoul, Qingdao, Bagerhat, and others.

The selected documents are structured by type (article, conference paper, book chapter, others), geography of research (57 countries, mainly from China, United States, India, Italy, Australia, United Kingdom, Spain, and South Korea), affiliation of authors (in addition to scientific and academic institutions (124), 34 are others, such as Google LLC, Huawei France Research Center, NASA Ames, Engineering Ingegneria Informatica).

A “cloud” (using WordItOut) and a “diagram” (using MS Excel) were generated to visualize the frequency of keyword usage. The low visibility of items (Immersive/Immersion, Immersive Technology/Immersive Technologies, Immersive Virtual Reality, Immersive Experience) reflects the small number of existing studies and the insufficient level of scientific representation of the corresponding dimension of the smart city environment. Thus, the epistemological need to expand the range of research on immersive art projects for smart cities becomes obvious.

Keywords of publications on “Smart City. Immersive” were structured by clusters, and bibliometric maps were developed using VOSviewer software version 1.6.20. Five clusters of items described: 1 – Immersive Technologies for Smart Urban Growth; 2 – Smart city development based on Extended Reality; 3 – Extended Reality for Sustainable Smart Cities; 4 – Intelligent Digital Ecosystems; 5 – Urban Development and Growth. A characteristic was compiled for each cluster, and relevant documents with the most significant number of citations were identified.

The results of the bibliometric analysis of documents on “Smart City. Immersive” can serve as a basis for further reflections on improving the methods of compiling global smart city indices, in particular, in the Smart City Index compiled by the International Institute for Management Development (in the “Activities” section). A potential area for further investigations is the analysis of the impact of immersive art projects on smart sustainable cities.

Declaration on Generative AI

During the preparation of this work, the authors used Grammarly in order to: Grammar and spelling check, Paraphrase and reword. After using this service, the authors reviewed and edited the content as needed and takes full responsibility for the publication’s content.

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