# Gender equality in smart sustainable cities: literature review

Alaa Ababneh [1]*, Ka Leung Lok[2], Hossein Abdeyazdan[3], Alex Opoku[4] and Charles Chen[5]

[1]Department of Art and Humanities, Digital Heritage, Universitat Autònoma de Barcelona, Barcelona, Spain, [2]Faculty of Business and Creative Industries, University of South Wales, Cardiff, United Kingdom, [3]Department of Architecture and Urban Design, Transforming City Regions, RWTH University, Aachen, Germany, [4]College of Business, University of Sharjah, Sharjah, United Arab Emirates, [5]College of Business, Hawai'i Pacific University, Honolulu, HI, United States

**Introduction:** The 2030 Agenda for Sustainable Development Goals (SDGs) has garnered significant attention globally, emphasizing the need for achieving the 17 goals that promote sustainable development. Among these, the fifth goal focuses on gender equality, which has become increasingly important in various nations. Notably, there is a recognized connection between SDG 11, which pertains to sustainable cities, and SDG 5. The concept of smart cities under SDG 11 is viewed as pivotal in enhancing gender equality. However, existing research exploring the relationship between smart cities and gender equality remains limited.

**Methods:** This study employs a bibliometric review technique utilizing the Bibliometrix tool to conduct a comprehensive analysis of literature related to SDG 5, SDG 11, and smart cities. This method allows for an extensive examination of existing research articles to identify trends and themes within the literature.

**Results:** The analysis revealed that many research articles frequently cited terms associated with sustainability, community, design, transportation, and mobility. It was found that most studies focusing on SDG 5 and SDG 11 through the lens of smart cities primarily aim to: (1) Understand and promote sustainability principles. (2) Address social issues. (3) Develop inclusive solutions. (4) Improve transportation for women and their commuting needs. Additionally, there is a noted increase in scholarly interest regarding health and climate issues about SDGs 5 and 11.

**Discussion:** The findings indicate a significant gap in the literature concerning the interplay between smart cities and gender equality, suggesting that further research is necessary to understand this relationship fully. The emphasis on sustainability principles and inclusive solutions highlights the potential for smart city initiatives to contribute positively to gender equality. As interest in health and climate issues grows within this context, it underscores the need for integrated approaches that address multiple dimensions of sustainable development while promoting gender equity.

KEYWORDS

SDG 5, SDG 11, smart sustainable cities, gender equality, Sustainable Development Goals, smart cities, urban equality

# 1 Introduction

Recently, there has been a growing recognition of the need to create equitable and environmentally sustainable communities throughout (Mensah, 2019). The achievement of this goal is becoming more feasible by implementing sustainable development objectives that target the resolution of global economic, social, and environmental challenges (Allen et al., 2018). The 17 objectives aim to promote sustainable development by addressing poverty, inequality, climate change, environmental degradation, peace, and justice (Anderson et al., 2022; Rouhi et al., 2024). Sustainable Development Goal 5 is dedicated to advancing gender equality and acknowledges the significance of tackling matters concerning the position, circumstances, and standing of women and non-binary individuals (Somerville and Pesantes, 2022). It highlights the need to ensure equal rights and opportunities for individuals of all genders while also striving to eradicate gender-based violence and discrimination. SDG 5 seeks to guarantee women's access to sexual and reproductive health services, including dependable contraception and secure abortion (Summerfield and Regan, 2021). Attaining Sustainable Development Goal 5 is essential for establishing a prosperous and sustainable global society while serving as a fundamental human entitlement (Mishra et al., 2023). SDG 5 also emphasizes the significance of women's empowerment in the aftermath of the pandemic, given that the consequences of COVID-19 have presented novel obstacles to women's rights and prospects (Strandberg, 2022; Sohrabi et al., 2022). Smart cities promote gender equality (SDG 5) through inclusive planning and services of all gender, and enhance sustainable urban development (SDG 11) by improve infrastructure and resource management, while non-smart cities often lack such advancements, limiting progress in both areas. Significance of relevant SDGs, particularly SDG 5 and SDG 11, lies in promoting inclusivity and sustainability in urban development, ensuring equitable opportunities and resilient urban environments for all (de Miguel González and Sebastián-López, 2022).

Non-smart cities have lower initial costs and simpler infrastructure but face challenges in efficiency and sustainability; smart cities leverage technology for improved services involve high implementation costs and privacy concerns.

The concepts of "cities," "development," "sustainability," "gender," and "smart" are interconnected and vital for understanding contemporary urban dynamics. Cities are urban centers characterized by high population density and diverse activities, serving as cultural and economic hubs (Al-Rashid et al., 2020). Development refers to the processes to improve the quality of life through economic, social, and infrastructural growth. Sustainability emphasizes the importance of meeting present needs without compromising future generations, encompassing environmental, social, and economic dimensions (Bevilacqua et al., 2023). Gender plays a crucial role in shaping access to resources and opportunities, as societal construction influences the roles and expectations of individuals (de Miguel González and Sebastián-López, 2022). Smart cities utilize digital technologies and data analytics to enhance service delivery, promote sustainability, and foster citizen engagement, striving to create more efficient and livable environments.

The research problem centers on understanding how smart city initiatives can effectively address gender inequalities within urban settings. While existing literature highlights the potential of smart cities to promote inclusivity, there is a critical gap in exploring specific mechanisms that empower marginalized groups, particularly women (Owais et al., 2024). Many studies focus on technological advancements without adequately assessing their impact on gender equity or the participatory processes in urban governance. There is lack of frameworks integrating gender considerations into the design and implementation of smart technologies, leading to a void in evidence-based strategies for enhancing women's roles in this context.

Discussing smart cities is increasingly relevant due to rapid urbanization, rising inequalities, and the urgent need for sustainable solutions. As cities confront climate change and social disparities, smart city initiatives offer innovative approaches to enhance resilience and improve quality of life. Addressing gender inequalities within this framework is essential to ensure that all urban residents benefit from technological advancements and sustainable practices. Engaging in this "hot topic" can lead to more equitable urban policies, improved community engagement, and the creation of cities that are not only smart but also just and inclusive. Developing smart sustainable cities be a practical approach to enhancing gender equality, while it is also central to SDG 11 (Sustainable cities and communities). SDG 11 seeks to create cities and human settlements that are inclusive, safe, resilient, and sustainable (Feng et al., 2023; Rauf et al., 2023). The primary objective is to tackle urban sustainability and mitigate the negative environmental consequences of urbanization (Memić et al., 2023) SDG 11 encompasses objectives such as enhancing air quality, optimizing waste management, and fostering the creation of environmentally friendly and accessible areas, thereby stressing the need for sustainable urban planning (Hussain et al., 2024; Rouhi et al., 2023). It highlights the need to create environmentally sustainable and inclusive communities, specifically promoting mental wellbeing and fostering social contact (Salehi Mava et al., 2022). SDG 11 is for establishing cities and urban areas that provide sufficient social, ecological, public, and technological infrastructures to fulfill the requirements of all inhabitants (Wallis et al., 2023; Ramani, 2022; Gupta and Degbelo, 2023). In parallel, smart cities use Information and Communication Technology (ICT) to enhance municipal administration and services, supporting SDG 11 (Sengupta and Sengupta, 2022; Evans et al., 2024). Smart city efforts often prioritize economic, social, and environmental advantages, such as increased energy efficiency, less waste, and better citizen services (Sengupta and Sengupta, 2022; Adibhesami et al., 2022). Incorporating smart city technology may aid in accomplishing SDG 11 objectives by fostering inclusive and sustainable urban development (Sarachaga, 2021; Zarie et al., 2024). There is a significant correlation between smart cities and SDGs, with SDG 11 being particularly relevant (Abdel-Razek, 2021).

Furthermore, SDG11 and smart sustainable cities can effectively promote gender equality and its related issues. SDG 11 recognizes women as vulnerable segment of society requiring protection, along with children, older persons, and persons with disabilities (East, 2022). The achievement of SDG 11 is crucial for promoting gender equality in urban planning and development.

Urban spaces and policies are gendered, and addressing the gender gap in urban planning is essential (Küfeoglu, 2022). SDG 11 also intersects with other sustainability goals, such as poverty reduction (SDG 1), education (SDG 4), clean water and sanitation (SDG 6), affordable and clean energy (SDG 7), economic growth (SDG 8), and climate action (SDG 13) (Vaidya and Chatterji, 2020). Limited research in the field of sustainable city design and gender equality highlights the significant impact of sustainable city design on advancing gender equality by addressing the unique needs and challenges faced by women in urban settings. Gender-sensitive urban planning can enhance women's safety, accessibility, and wellbeing (Barnes, 2021; Yadav and Kumari, 2021; Gutiérrez Mozo, 2020; Rampaul and Magidimisha-Chipungu, 2022; Campisi et al., 2022). In this regard, integrating gender perspectives into urban planning and design ensures women's involvement in decision-making processes and acknowledges their experiences, ultimately leading to more inclusive public spaces (Dalu and Manyani, 2020). The notion of empowerment is fundamental to attaining gender equality in intelligent, sustainable cities. Empowerment denotes the procedures that allow individuals, especially women and marginalized groups, to assert control over their lives, make decisions, and impact decision-making processes (Morrow, 2018).

At their core, Smart Sustainable Cities aim to integrate social, economic, and environmental dimensions into urban planning and governance. By utilizing smart technologies, cities can optimize resource allocation, improve service delivery, and foster greater community engagement. This potential for enhanced efficiency and inclusivity positions Smart Sustainable Cities as unique opportunity to identify and mitigate the factors contributing to urban inequalities.

Yet, the relationship between smart initiatives and urban equality is complex. While technology can provide tools for empowerment and equitable access to resources, it also inadvertently exacerbate existing disparities if not implemented with a focus on inclusivity. Addressing issues such as empowering urban equality divide and ensuring that marginalized communities have voice in decision-making processes are essential for realizing the full benefits of smart urban development (de Miguel González and Sebastián-López, 2022).

Moreover, some studies have underscored the direct role of smart cities in promoting gender equality through technological advancements aimed at creating safer urban environments for women and individuals with diverse gender identities (German et al., 2023; Voigt, 2023), thus fostering the inclusion and active participation of women within the urban framework (Sankar et al., 2022). The smart city concept emphasizes technology and citizen participation to enhance the quality of life for all residents, yet gender disparities often remain unaddressed in these initiatives. To effectively tackle gender inequality, smart cities should implement strategies that include mainstreaming gender considerations in urban policies, ensuring that women's voices are heard in decision-making processes, and utilizing technology to improve access to services for marginalized groups (Nesti, 2019). Furthermore, fostering inclusive civic engagement can enhance democratic participation and ensure that urban development reflects the needs of all genders, thereby contributing to a more equitable urban environment (Bingöl, 2022). The ability of technology to empower women and progress gender equality defines the link between SDG 5 and smart cities. Using gender-sensitive designs and the application of cutting-edge technologies, urban designers can create inclusive settings that meet the unique needs of women, so enabling the realization of SDG 5 within the general framework of sustainable urban development (Sharifi et al., 2024; Terraza et al., 2020). Using enhanced information and service access, smart cities may empower women. Information and communication technology (ICT) integration into urban planning helps to provide platforms with for women to gain access to economic possibilities, healthcare, and education (Eyieyien et al., 2024; Adibhesami et al., 2024a). When allowing women to interact with technology, smart city initiatives help to close gender gap in many different fields and hence encourage higher involvement in civic life and decision-making procedures. However, progress toward SDG 11, especially in line with gender equality, has been slow, and there is a need to accelerate efforts to make cities sustainable and resilient, especially in the face of future disasters like the COVID-19 pandemic (Hettiarachchi, 2022; Adibhesami et al., 2024b). Also, the role of smart sustainable cities in promoting gender equality is critical but often overlooked aspect of urban planning and management (Asteria et al., 2020). Gender-responsive approaches are essential in ensuring that the benefits of technology and innovation are equally accessible to all members of the community, particularly women (Abrishami and Chamberlain, 2023). However, mainstreaming gender equality in smart cities presents theoretical, methodological, and empirical challenges (Nesti, 2019). It is crucial to consider the intersectionality of gender with other social factors in the design and implementation of smart city initiatives (Fernanda Medina Macaya et al., 2021). By doing so, smart sustainable cities can create more inclusive and equitable urban spaces for all residents.

The relationship between SDG11, smart cities, and SDG5 can be comprehended directly and indirectly. A comprehensive review study to synthesize existing research and pinpoint crucial connections and metrics is needed to identify a significant gap in the current literature. Addressing this gap is essential for enhancing future research trajectory in this domain.

Hence, the primary focus of the present study is to provide comprehensive analysis through an examination of the existing literature on SDG5, SDG11, and smart cities. Achieving this analysis as the primary goal can lead to secondary objectives such as identifying the most important keywords, trending topics, links, and research gaps. To accomplish these objectives, a bibliometric analytical approach was employed. The identified articles underwent analysis utilizing the Bibliometrix tool, and the resulting analyses were classified based on the specified objectives. The findings have the potential to inspire new studies in the areas of gender equality and sustainable urban development, motivating other scholars and city planners to explore these topics further. This research can provide a crucial viewpoint for developing sustainable cities prioritizing gender values and equality by implementing intelligent and technological solutions.

## 1.1 Theoretical framework

Theoretical models of this study help to explain our bibliometric results by showing how clever city initiatives can effectively include gender-sensitive designs and rules. This

integration is vital since it aligns with the Sustainable Development Goals (SDGs), namely SDG 11 which emphasizes sustainable cities and communities and SDG 5, which tackles gender equality. The junction of these goals highlights the need of urban design that stresses gender justice and solves environmental sustainability.

Smart technologies have been embraced by cities including Amsterdam and Barcelona to improve women's access and safety. Barcelona has put smart lighting systems in public spaces to increase nighttime visibility and safety, especially addressing problems disproportionately affecting women. Moreover, the city has developed smartphone apps providing real-time public transportation data, so helping women to more safely and effectively negotiate metropolitan environments (Roberts, 2023; Veloso et al., 2024).

By including women's opinions into the design of public spaces and transportation systems, Amsterdam has developed a gender-sensitive urban plan. The city's activities include the creation of safer bike lanes and the enhancement of public transportation options catered to the different needs of women, including accessible elements for those with children or disabilities (Noori et al., 2020; Mancebo, 2020). These useful tools show how theoretical models can direct actual initiatives to progress gender equality in smart city settings.

Examining these case studies demonstrates that initiatives in smart cities not only bring about technology advancement but also serve as venues for fostering inclusivity and lessening of gender inequalities. SDG 5 and SDG 11 development depends on the congruence between theory and practice, thereby promoting more equal urban environments.

Literature on urban equality and smart cities is rapidly evolving, yet it presents significant gap in exploring the concept of "empowerment," particularly in the context of marginalized communities (Owais et al., 2024). While the current discourse highlights the integration of smart technologies and gender-sensitive designs, it often overlooks how these initiatives can actively empower individuals, especially women, in urban environments. Empowerment should be central theme in this dialogue, as it encompasses access to resources and the ability to influence decision-making processes and shape one's environment (Al-Rashid et al., 2020; Owais et al., 2024).

Existing literature primarily serves as preliminary mapping of research area, providing insights into how smart city initiatives enhance inclusivity and address urban inequalities. However, it falls short of critically examining the mechanisms through which empowerment occurs (de Miguel González and Sebastián-López, 2022). For example, while cities like Barcelona and Amsterdam implement smart technologies to improve safety and accessibility for women, the literature does not sufficiently address whether these measures translate into genuine empowerment. Are women merely beneficiaries of improved infrastructure, or do they also gain a voice in decision-making that affect their lives?

Integration of empowerment into the dialogue around smart cities could strengthen the connection to Sustainable Development Goals (SDGs). By explicitly linking empowerment to SDG 5 and SDG 11, researchers provide a more comprehensive framework emphasizing the outcomes of smart initiatives and the processes enabling marginalized groups to advocate for their needs and rights.

The relationship between cities, development, gender, and sustainability is essential for understanding urban dynamics, particularly as urbanization continues to rise (Owais et al., 2024). Sustainable urban development aims to promote environmental stewardship and social equity, addressing the unique challenges marginalized groups, especially women face.

Smart cities present advantages in combating urban inequality by utilizing data-driven decision-making to improve services for underserved populations and enhance connectivity to essential resources, challenges such as the digital divide, privacy concerns related to surveillance, and the risk of gentrification remain significant (de Miguel González and Sebastián-López, 2022; Owais et al., 2024).

Conversely, non-smart cities offer accessibility and foster strong community ties, enabling greater participation in governance. Yet, they often struggle with inefficient resource allocation and lack the technological tools to address sustainability issues effectively.

Smart city construction significantly reduce inequality, but the impact varies across different demographics, often favoring those already in advantageous positions. Researchers have noted that the spatial effects of smart cities can exacerbate inequalities by primarily benefiting affluent classes, leading to a need for inclusive policies that address the diverse needs of all urban residents (Owais et al., 2024).

Research at the intersection of urban equality, smart cities, and gender highlights the need to understand how smart technologies can promote inclusiveness. Key gaps include the lack of frameworks addressing gender in smart city initiatives, the need for studies on empowerment mechanisms, and an understanding of how to ensure equitable access to smart technologies. Addressing these gaps can lead to more equitable urban environments prioritize sustainability and gender equity.

## 2 Method

The systematic review method was chosen to achieve the main objective of this research. The need to identify topics and research on Sustainable Development Goals related to gender equality and smart cities was prioritized. Considering that these topics account for hundreds of articles every year, the authors needed to ensure the quality of the report for systematic review. Therefore, the PRISMA checklist gave the systematic review process a logical order. This checklist (accessed April 3, 2024) has 27 items and four sequential steps, including identification, screening, eligibility, and inclusion, designed to help authors conduct better systematic reviews (see Figure 1) (Page et al., 2021).

Scopus database was used to obtain the required data for bibliometric analysis. Scopus is favored for bibliometric analysis due to its comprehensive coverage and quality data, enabling deep research insights (Velasco López and Cobo Martín, 2023). It offers a wide selection of publications from various fields that facilitate the identification of research trends, author collaborations, and intellectual structures (Saputro et al., 2023). Authors need to use three search strings to extract articles related to SDG 5, SDG 11, and smart cities. The following three search strings were used in the Article title, Abstract, and Keywords section of Scopus:

**FIGURE 1**
Procedures for systematic review based on PRISMA checklist (Page et al., 2021).
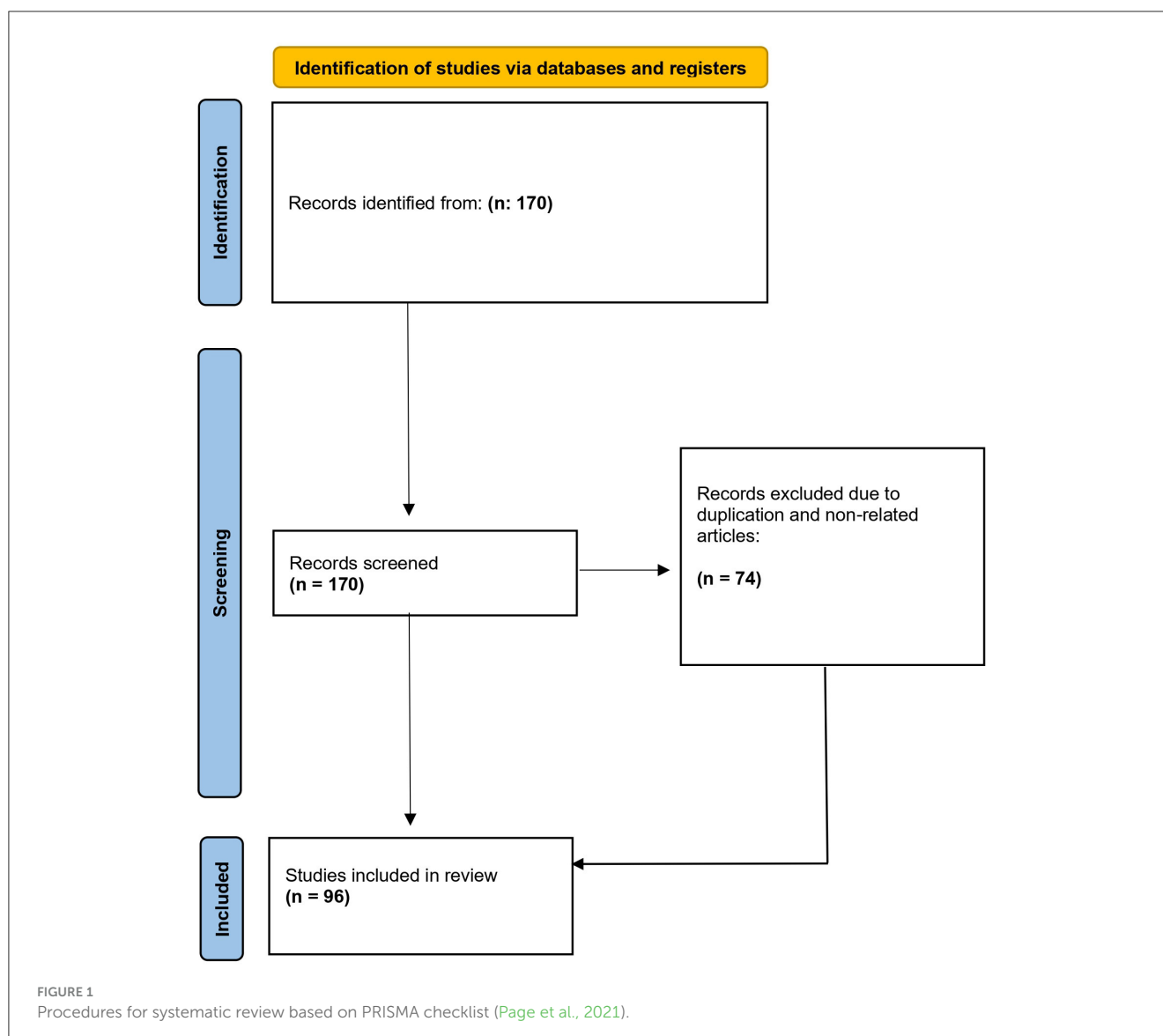
TS1:

*(("sdg-5" OR "Sustainable Development goal five" OR "Sustainable Development goal 5" OR "Sustainable Development goal Fifth" OR "SDG-five")) AND (("sdg-11" OR "Sustainable Development goal eleven" OR "Sustainable Development goal 11" OR "Sustainable Development goal the eleventh" OR "SDG-eleven"))*

TS2:

*(("sdg-11" OR "Sustainable Development goal eleven" OR "Sustainable Development goal 11" OR "Sustainable Development goal the eleventh" OR "SDG-eleven")) AND (("gender*" OR "Gender equality" OR "women*" OR "woman*"))*

TS3:

*(("gender*" OR "Gender equality" OR "gender inclusivity" OR "women*" OR "woman*")) AND (("Smart Cit*" OR smart AND cities OR intelligent AND city OR wisdom AND city))*

The first search field was designed to simultaneously identify the most important articles related to SDG 5 and SDG 11. However, gender equality appeared to be related to SDG 11 in articles outside the scope of the SDG 5 discussion. Therefore, the second

search string was also designed to cover this connection. Finally, considering the focus of this research on smart cities, it was necessary to identify the connection between smart cities and gender equality with the help of search string 3. These search strings were applied in Scopus on March 27, 2024. Finally, 170 articles were identified. First, non-English articles were removed, and then, by carefully studying the title and Abstract of each article, 74 irrelevant and inaccessible articles were removed. Articles not generally about gender gaps or equality and without specific connections to smart cities and SDG 11 were excluded. Finally, 96 articles remained, and the full information of these articles, including Citation information, Bibliographical information, Abstract and keywords, Funding details, and Other information, were downloaded and analyzed by the Bibliometrix software. This software can be called in the R software and downloaded for free through http://www.bibliometrix.org. Bibliometrix is a comprehensive tool for bibliometric analysis due to its extensive set of techniques and user-friendly interface through Biblioshiny (Arora and Arora, 2022). It allows researchers to analyze bibliographic data effectively

TABLE 1 Main information.

| Main information about data | |
|---|---|
| Timespan | 2003:2024 |
| Sources (journals, books, etc.) | 78 |
| Documents | 96 |
| Annual growth rate % | 5.37 |
| Document average age | 3.47 |
| Average citations per doc | 13.52 |
| References | 4,549 |
| Keywords plus (ID) | 635 |
| Author's keywords (DE) | 442 |
| **Authors** | |
| Authors | 290 |
| Authors of single-authored docs | 18 |
| **Authors collaboration** | |
| Single-authored docs | 20 |
| Co-authors per doc | 3.15 |
| International co-authorships % | 29.17 |
| **Document types** | |
| Article | 62 |
| Book | 2 |
| Book chapter | 15 |
| Conference paper | 13 |
| Review | 4 |

and efficiently. In addition, Bibliometrix can generate scientific maps using special software and improve the analysis process (Abbas et al., 2022). Systematic review is crucial for identifying research gaps, trends, and future directions in various fields (Abdullah et al., 2023). It aids in avoiding duplication of efforts, ensuring effective resource utilization, and directing future research endeavors. By analyzing publication trends, influential authors, keyword co-occurrence networks, and thematic evolution, bibliometric analysis provides valuable insights for researchers (Ellili, 2024). Therefore, this method is suitable for achieving the primary goal of this article, which is to comprehensively analyze the literature around SDG5 and SDG 11 and the smart city. Secondary objectives were also achieved by identifying the most important keywords, trending topics, links, and research gaps. Primary data are shown in Table 1. Also, analyses such as co-occurrences, citations, and co-citations were done with the help of Bibliometrix.

## 2.1 Valuable case studies

We found several pertinent case studies showing the pragmatic uses of gender-sensitive designs and policies in response to the demand for more complete knowledge of smart city projects

tackling gender equality (see Table 2). These case studies were chosen because they fit our bibliometric study's developing themes and were successfully used in several metropolitan environments. Including these case studies within our approach helps us to offer a more complex, richer viewpoint that enhances our quantitative results. This mixed-methods approach will enable us to test our bibliometric results and investigate how particular smart city projects have successfully addressed gender equality, strengthening our work's general robustness.

# 3 Results and discussions

## 3.1 Publication trends

Our research of smart city have shown promise in advancing urban equality and promoting gender empowerment by addressing the unique challenges faced by marginalized groups, particularly women. Tailored interventions improve access to essential services and enhance safety, while digital tools empower women to engage in policymaking. Economic opportunities and sustainability efforts foster financial independence and healthier living conditions, highlighting the need for gender considerations in smart city planning.
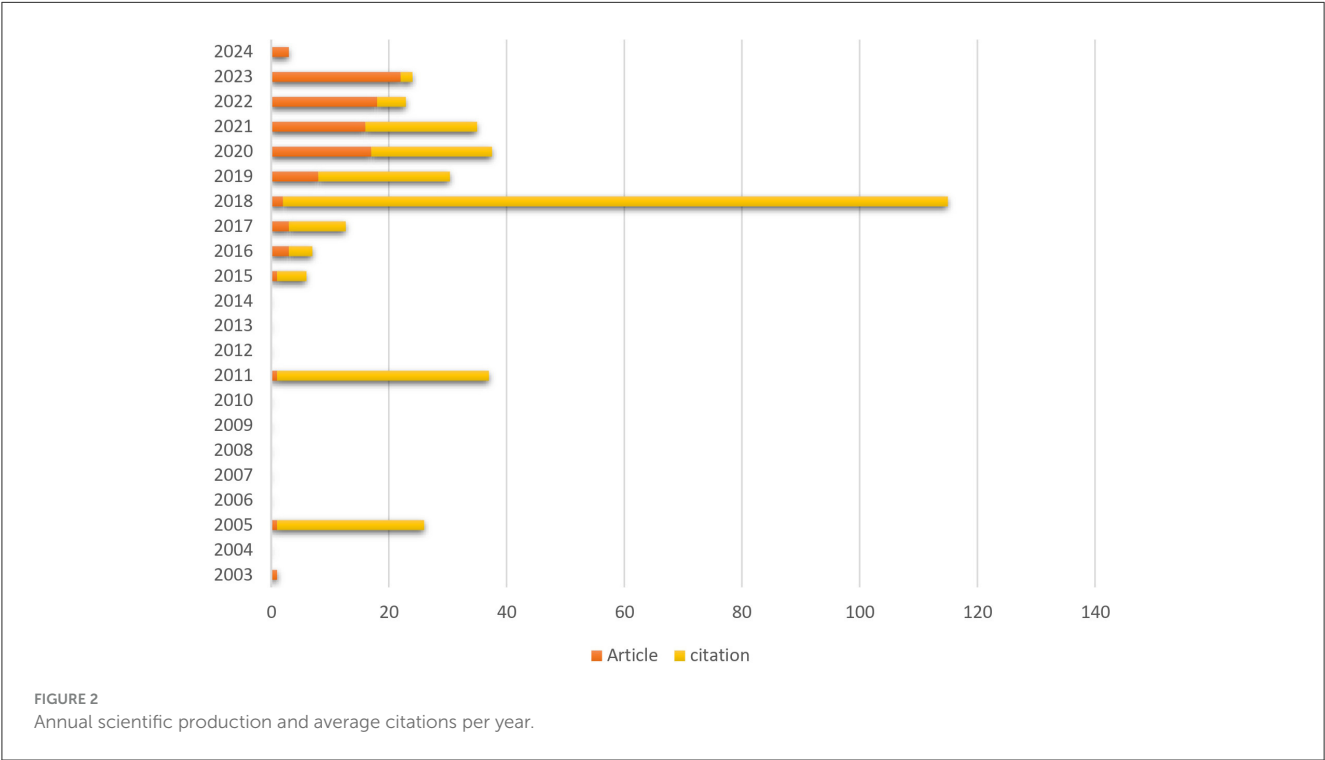
Figure 2 illustrates the progress of publishing and citation activities concerning SDG 5, SDG 11, and smart cities articles. Notably, from 2003 to 2014, there needed to be more significant publications. However, starting from 2015 up to 2024, there was a consistent rise in publications and citations. This surge can be attributed to the growing global focus on Sustainable Development Goals. These objectives were established during the United Nations Conference on Sustainable Development in Rio de Janeiro, Brazil, in 2012 and were subsequently adopted in 2015 by all UN member states as part of the 2030 Agenda for Sustainable Development (Rosa and Hassmiller, 2020; Buss et al., 2016). Hence, the increased publishing and citation activities related to SDG 5, SDG 11, and smart cities can be viewed as an endorsement of the 2030 agenda.
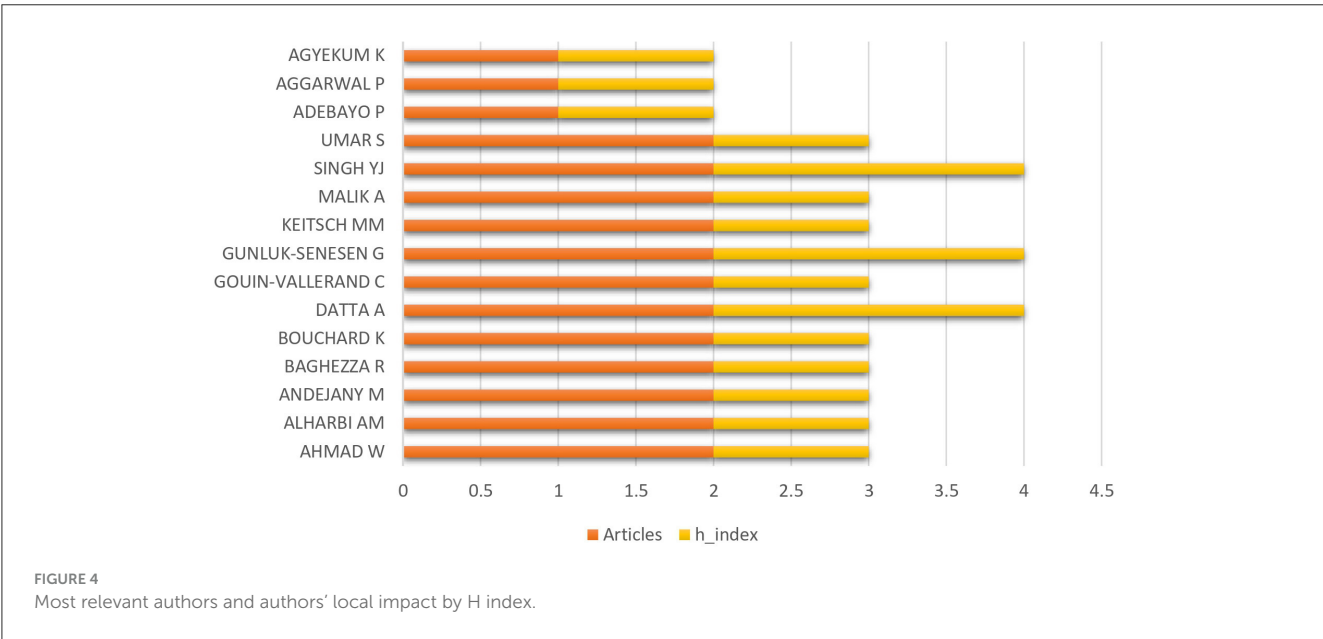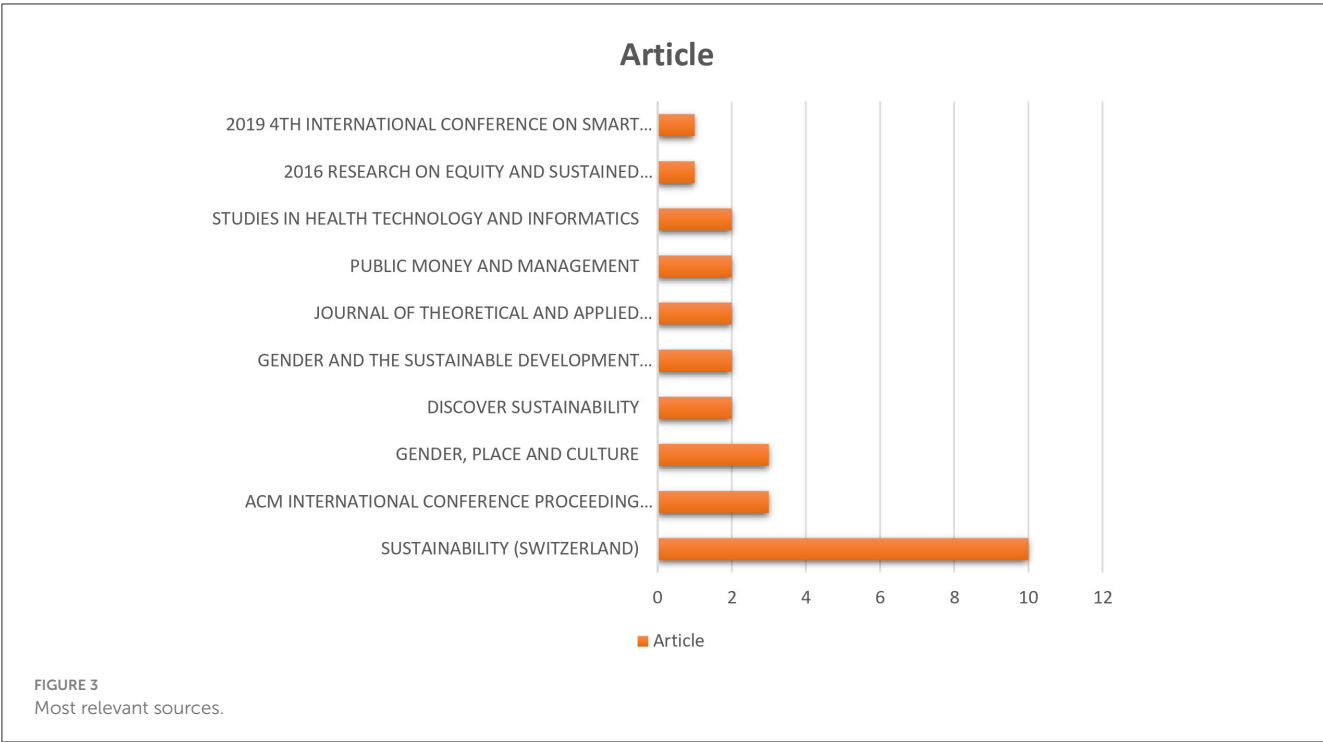
Figure 3 shows the critical academic journals that disseminate research articles within the field under investigation. The MDPI journal *Sustainability* has published 10 articles, while *Gender, Place & Culture* and *Discover Sustainability* journals have each published three articles. *Sustainability* is a globally recognized, peer-reviewed journal that encompasses various subjects related to sustainability and sustainable development. Consequently, it is reasonable to see a higher volume of articles published on topics concerning Sustainable Development Goals. Additionally, the journal *Gender, Place & Culture* has made significant contributions by focusing on gender-related issues and human geography.

Figure 4 illustrates the key authors who have made significant contributions. While approximately 12 authors have a similar number of articles, three authors stand out for their impact. These authors are Datta A, Singh Yj, and Gunluk-Senesen G. Datta A's work delves into the correlation between urban spaces and gender rights within the context of SDG5 and SDG11, as well as the significance of digital-oriented urban public spaces in addressing gender issues (Datta, 2021; Datta and Thomas, 2022). Singh Yj has conducted two influential studies on women, intelligence,

TABLE 2  Case studies on SDG 5 and SDG 11.

| City | Initiative/project name | Objectives | Strategies implemented | Outcomes | References |
|------|------------------------|------------|------------------------|----------|------------|
| Barcelona | Smart lighting project | Improve safety for women in public spaces | Installation of smart lighting systems in high-risk areas | Reduced crime rates and increased women's sense of safety | Roberts, 2023; Veloso et al., 2024 |
| Amsterdam | Gender-sensitive urban planning | Enhance accessibility for women | Inclusive design processes involving community feedback | Improved public transport services for women | Roberts, 2023; Veloso et al., 2024 |
| Vienna | Gender mainstreaming in urban planning | Create inclusive public spaces | Gender impact assessments in urban projects | Enhanced safety and accessibility for women | Young, 2024 |
| Toronto | Smart city strategy | Promote gender equity in urban development | Community engagement initiatives focusing on women's needs | Increased participation of women in urban planning processes | Tierney, 2019 |
| Jakarta | Multimodal public transportation evaluation | Assess service quality from a gender perspective. | Gender-based service quality evaluation, focus group discussions, surveys. | Identification of service gaps and improvements in user satisfaction among different genders. | Owais et al., 2024 |
| Singapore | Smart nation initiatives | Improve urban planning and quality of life through technology. | Integration of IoT, data analytics, AI in urban planning and transportation. | Reduced traffic congestion by 35%, increased energy efficiency by 20%. | Chan and Chye, 2023 |
| Tangerang City | Smart city initiatives for resilience | Enhance city resilience to disasters, including COVID-19. | Development of software applications, community engagement programs. | Improved disaster response capabilities and community awareness during emergencies. | Kusumastuti et al., 2022 |
| Lusaka | Gender equality and economic growth | Promote gender equality to boost economic development. | Policies for women's workforce participation, access to education and health services. | Increased women's participation in the economy, enhanced household incomes. | Ngulube et al., 2024 |
| Pune | Smart city governance | Integrate citizen participation in urban governance and service delivery. | Community engagement in budgeting and waste management processes. | Improved public services and citizen satisfaction through participatory governance. | Tayeng et al., 2024 |



FIGURE 2
Annual scientific production and average citations per year.

FIGURE 3
Most relevant sources.



FIGURE 4
Most relevant authors and authors' local impact by H index.

and mobility (Uteng et al., 2019; Singh, 2020). Gunluk-Senesen G's research centers on gender budgeting and its implications for urban and Sustainable Development Goals (Gunluk-Senesen, 2021). Overall, there needs to be more expert researchers in this particular field. Despite the increasing number of articles related to SDG5, SDG11, and smart cities, as indicated in Figure 2, the need for more specific attention from researchers remains a significant drawback.

Figures 5, 6 depict the nations with the most publications within the specified research area. Noteworthy countries such as the United States, India, Spain, Saudi Arabia, China, Australia, and

Canada are at the forefront of this field. The United States, with its extensive background in the modern era, particularly in the fight for women's rights and gender equality, can be seen as justified in having a higher publication rate. Moreover, countries like India and Saudi Arabia, which have experienced a significant increase in article publications post-2015, hold significance (Sirri, 2024; Mishra et al., 2014). These nations have shown a particular focus on gender equality matters in recent years, especially following the 2030 agenda, as gender inequality has been deeply rooted in both Saudi Arabia and India. The rise in publications from both countries indicates a broader recognition that sustainable
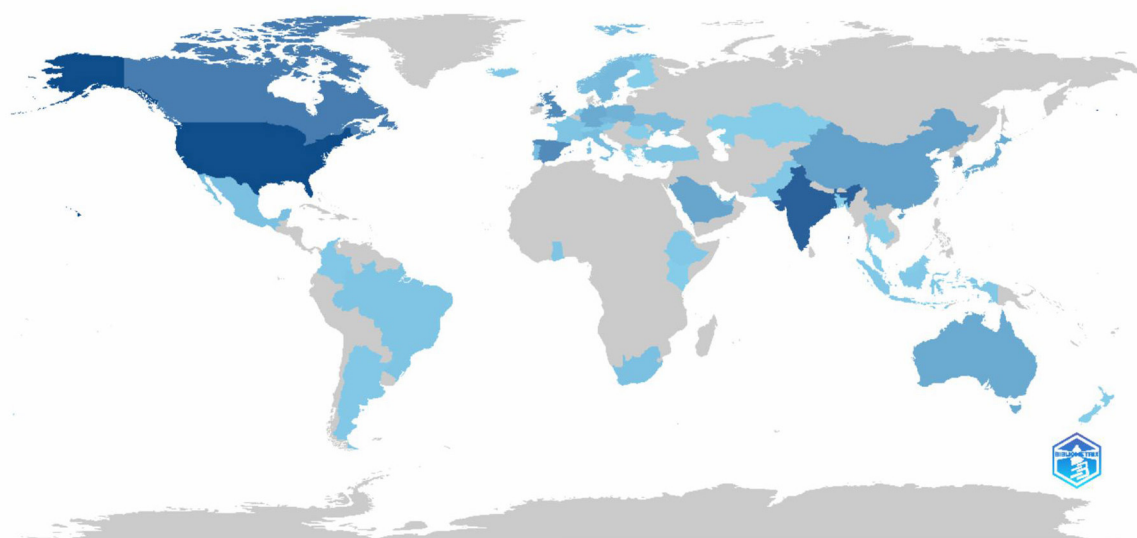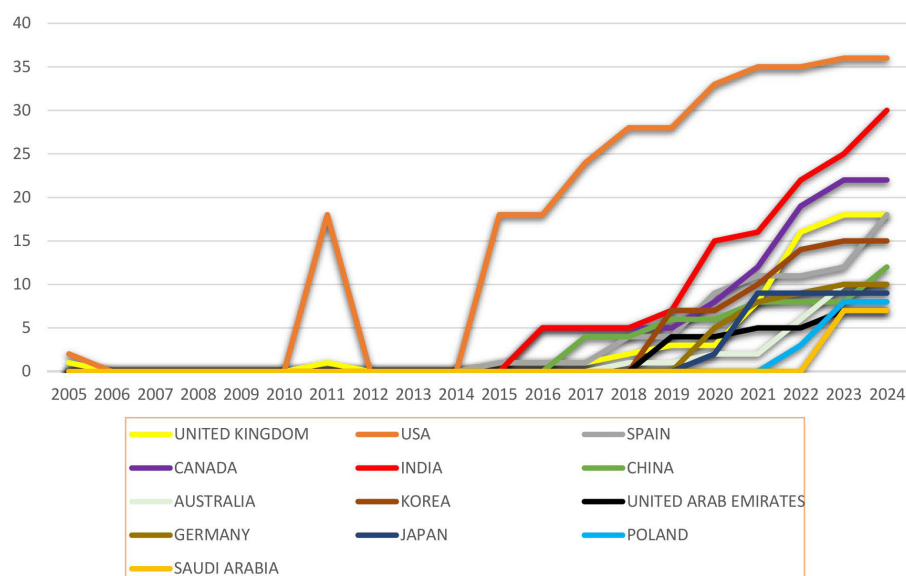
FIGURE 5
Country scientific production.



FIGURE 6
Country production over time.

development relies on gender equality. The academic community is increasingly exploring innovative concepts and effective strategies to advance gender equality, as these nations continue to confront past inequalities. For instance, Information and Communication Technology (ICT) is very important in India in empowering women by giving them access to impossible information, resources, and opportunities (Singh and Vanka, 2020). Singh and Vanka (2020) draw attention to an Indian government project that effectively used ICT to improve women's empowerment, proving how technology may enable access to health services, education,

and economic possibilities (Mohimi and Esmaeily, 2024). This example shows how clever city projects may use ICT to build more inclusive urban settings that meet women's particular demands (Singh and Vanka, 2020). Furthermore, in Saudi Arabia, studies center on how smart city projects could improve urban mobility for women, therefore addressing gender inequalities in access to and transit within metropolitan settings (Asaad et al., 2024). Using cutting-edge technologies and data analytics, the toolkit seeks to produce inclusive and fair mobility solutions catering especially to the requirements of women in Saudi Arabia,
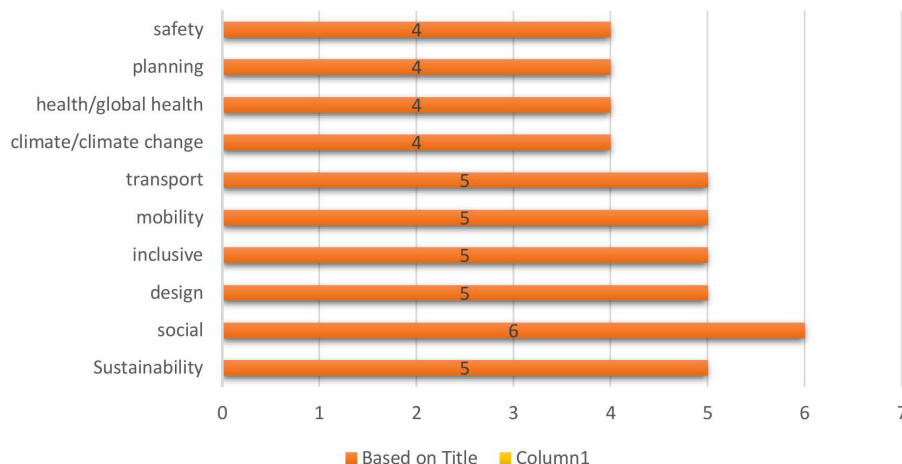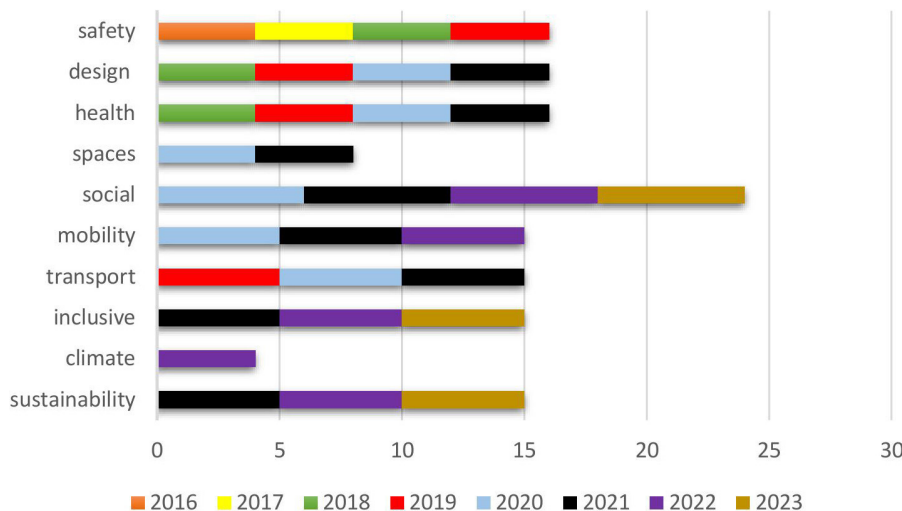
**FIGURE 7**
Most relevant words.



**FIGURE 8**
Trend topics.

therefore complementing the more general objectives of smart city development (Asaad et al., 2024).

## 3.2 Core subjects and trends

Figure 7 illustrates the distribution of key terms central to the articles examined in this study. Notably, terms like women, gender, Sustainable Development Goals, urban, and smart city are deemed significant as they form the foundation of this research. Consequently, these terms were deliberately excluded from the analysis to explore a different set of associated keywords. This approach aided in determining the thematic relevance of the researchers and their primary focus on the diverse subjects covered in the articles. The examination was conducted within the titles of the articles. Keywords such as sustainability, social issues,

transportation, mobility, and inclusivity emerged as the most prevalent and recurrent in the titles of the identified articles. Within the realm of social issues, various topics were addressed, including the significance of human and gender considerations in smart cities (Asteria et al., 2020; Lynch, 2020), social necessities, frameworks for achieving sustainable development (Sajwani and Al-Othman, 2023), social media and sustainable tourism (Hysa et al., 2022), and social data analysis for sustainable urban areas (Manzoor et al., 2023). Furthermore, in the domain of design, the integration of gender perspectives in urban planning and sustainable design (Keitsch, 2022), as well as the design of urban spaces tailored to women's requirements (Lee et al., 2017), were highlighted as key areas of research.

Studies in the field of inclusiveness have also addressed issues such as inclusive cities and the security and freedom of women (Datta, 2021), inclusiveness in access to Information and

FIGURE 9
Co-occurrence network based on title.
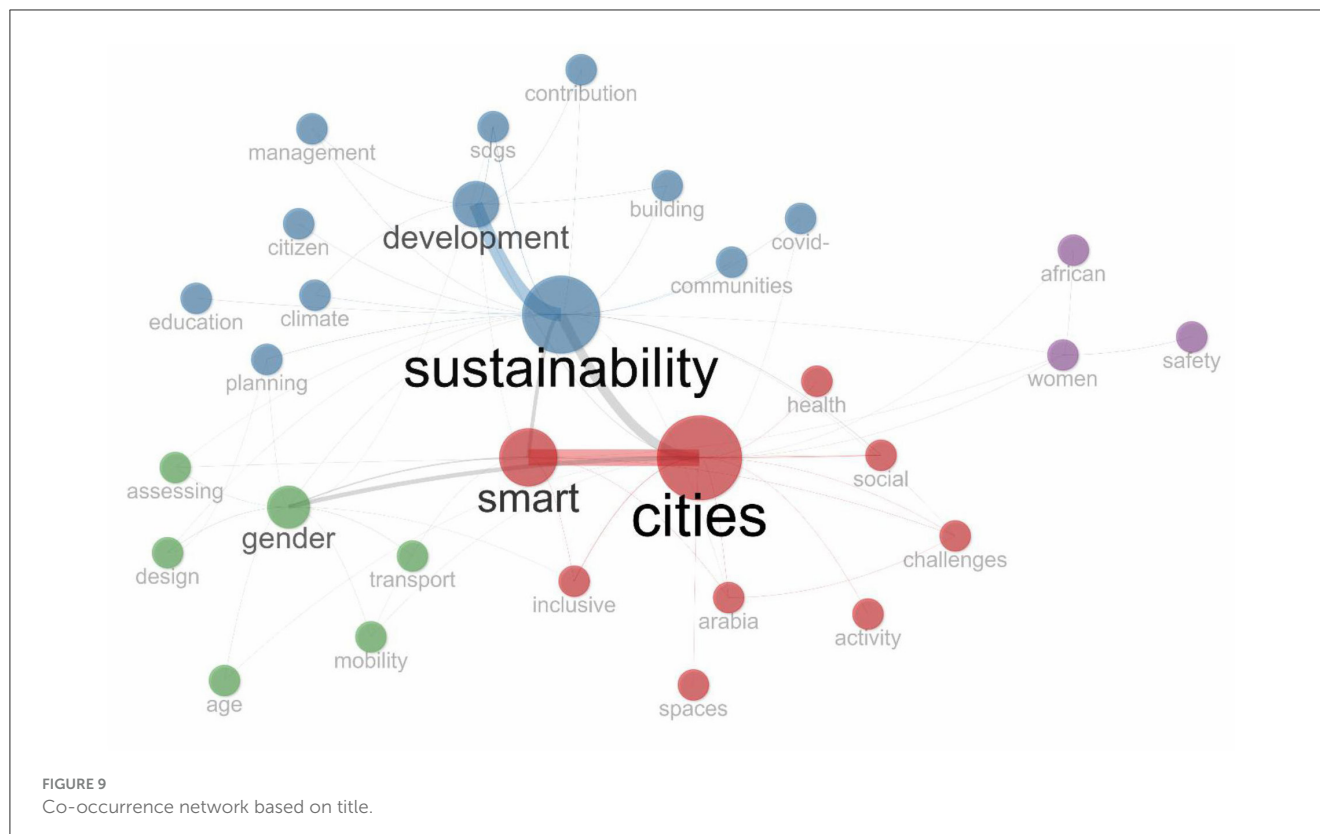
Communication Technology (Othman et al., 2023), the use of smart technology for the design of inclusive urban public spaces (German et al., 2023; Itair et al., 2023). Moreover, the field of transportation and mobility garnered substantial attention. Research on women's transportation modes (Uteng and Susilo, 2021), smart sustainable transportation practices (Bamwesigye and Hlavackova, 2019), the role of women in the smart transportation sector (Monteagudo and Colleoni, 2021; Pirra et al., 2021), and the intersection of women with transportation in developing nations were identified as pivotal areas of study within the transportation sector (Priya Uteng and Turner, 2019). Conversely, in the context of mobility, subjects such as ICT-driven mobility services (Mostofi, 2022), gender considerations in mobility services (Pirra et al., 2021), smart mobility solutions, and gender parity were of particular interest to researchers (Singh, 2020; Lindkvist, 2024). Cities like Vienna have included gender considerations into urban planning, prioritizing women's safety and accessibility in the construction of public places (Young, 2024). These examples offer empirical evidence for the capacity of smart cities to improve gender equality.

In recent years, there has been a notable emphasis on climate change and health in the articles extracted, as illustrated in Figure 8. This focus can be attributed to the rise of the COVID-19 pandemic and the escalating impact of climate change. Consequently, global attention has shifted toward addressing global health and climate change issues. For instance, research has delved into the empowerment of women's leadership in healthcare and the formulation of gender equality policies aimed at enhancing gender wellbeing through resource allocation (Gunluk-Senesen, 2021; Ebron and Andenoro, 2023). Furthermore, several studies

have highlighted the correlation between advancing global efforts against climate change and SDG 5 (Venkatramanan et al., 2021; Laumann et al., 2022). Recent research indicates that SDGs 5 and 11 are crucial in promoting optimal health and a sustainable global climate (Álvarez-Miño and Montoya, 2022). Current research underscores the significance of gender-related measures in narrowing the gender gap and facilitating decarbonization efforts (Aparisi-Cerdá et al., 2024). Findings depicted in Figures 7, 8 demonstrate a growing body of literature on global health and climate, focusing on gender-related research in these domains (Reid and Simatele, 2021; Castelo et al., 2024). But our research turned up a notable dearth of actual data on gender-sensitive smart city projects. Also, cities like Toronto's Smart City Strategy highlight how integrating gender perspectives can lead to more inclusive urban environments (Tierney, 2019), thereby supporting our bibliometric findings.

Figure 9 provides an overview of the articles extracted in this study. The analysis of keyword co-occurrence is presented in Figure 9. Generally, examining the co-occurrence of keywords aids in uncovering connections and relationships among various concepts and themes within a specific field of study (Vătămănescu and Vintilă, 2023). Through the analysis of the co-occurrence network, researchers can pinpoint hot spots, research trends, and the frequency of particular keywords over time (Liu et al., 2023). Hence, we utilized synchronicity analysis in Bibliometrix software to pinpoint significant subject areas and priority research topics within SDG 5, SDG 11, and Smart City literature. In Figure 9, the node's size reflects the frequency of keywords, while the thickness of the links between nodes corresponds to the strength of connections.

As depicted in Figure 9, the keywords Cities, Smart, Sustainability, and Development exhibit the most significant node of links based on the current research. This association has led to four distinct clusters represented by red, blue, green, and purple colors.

The blue cluster contains the highest number of nodes, focusing on sustainable development issues. Discussions within this cluster predominantly revolve around management (Nugent et al., 2018; Puntillo, 2023), planning (Keitsch, 2022; Maalsen et al., 2023; Dankevych et al., 2020), climate (Venkatramanan et al., 2021; Laumann et al., 2022; Álvarez-Miño and Montoya, 2022; Aparisi-Cerdá et al., 2024), education (Ramírez-Montoya et al., 2023; Chan et al., 2023), and the impact of COVID-19 (Manzoor et al., 2023; Shulla et al., 2021). Following the blue cluster, the red cluster emerges as the second largest, centering on research related to smart cities. This cluster highlights the interconnectedness of health (Buttazzoni et al., 2020), social (Asteria et al., 2020; Lynch, 2020; Sajwani and Al-Othman, 2023), and inclusive (German et al., 2023; Othman et al., 2023; Itair et al., 2023) research within the context of smart city development. The green cluster is primarily linked to gender-related topics, with keywords such as transportation (Uteng and Susilo, 2021; Monteagudo and Colleoni, 2021; Pirra et al., 2021; Priya Uteng and Turner, 2019), mobility (Mostofi, 2022; Baghezza et al., 2022; Singh, 2020), and design (Voigt, 2023; Keitsch, 2022; Lee et al., 2017) showing significant co-occurrence. Lastly, although the smallest, the purple cluster sheds light on studies concerning women in security (Uteng et al., 2019; Gulati et al., 2020) and the African context (Ebron and Andenoro, 2023; Kauzya, 2020; Adebayo et al., 2022; Ngang, 2021).

The findings indicate that while the literature on the role of sustainable smart cities in resilience is still developing, there is a growing recognition of how these cities can address social challenges, particularly concerning health and inclusion for women. The co-occurrence of keywords such as "cities," "smart," "inclusive," "social," "health," and "challenges" suggests that researchers are beginning to explore the potential of smart city initiatives as solutions to pressing social issues.

Smart cities utilize technology and data to develop urban settings that are both efficient and inclusive. Incorporating intelligent technologies in urban planning can augment access to healthcare services, boost public safety, and promote social cohesion. Research indicates that smart city frameworks can enhance health outcomes by delivering real-time data on public health trends and fostering more responsive healthcare services (Mohammadzadeh et al., 2023). Moreover, these technologies can establish inclusive environments that address the varied demands of all people, including excluded groups like women (Bibri and Krogstie, 2020). The term "sustainability" was anticipated due to the research's focus.

The results highlight the necessity of implementing integrated strategies incorporating gender-sensitive designs in smart city projects. Practical examples from towns like Dammam, which has enacted gender-responsive public transport policy, demonstrate how these methods can facilitate the attainment of SDG 5 and SDG 11 (Al-Rashid et al., 2020). The results reveal notable deficiency in the literature about the relationship between smart cities and gender equality. This study highlights that smart city efforts can empower women by addressing their specific needs in urban settings. Integrating gender-sensitive designs into

urban planning enables towns to establish safer public places and improve women's involvement in civic engagement (de Miguel González and Sebastián-López, 2022). This empowerment enhances individual well-being while promoting community resilience and social equality.

## 3.3 Valuable case studies

The incorporation of qualitative case studies with our bibliometric results greatly enhances our comprehension of how smart city efforts might foster gender equality. Analyzing real-world examples allows us to corroborate the trends discovered in the research and emphasize effective techniques utilized by urban planners and policymakers. Projects in cities such Barcelona and Amsterdam show how gender-sensitive designs could enhance general urban well-being for women by means of safety, accessibility, and other aspects. These case studies give empirical support for our bibliometric study and provide useful knowledge for next projects on urban development targeted at advancing gender equity. The next table summarizes important details about these case studies including their objectives, applied strategies, and outcomes.

## 4 Conclusion

This research used a review technique to analyze the current literature on the correlation between smart cities and SDGs 5 and 11. Ninety-six publications published from 2003 to 2024 were found and evaluated using Bibliometrix software. The main objective of this research was effectively achieved, resulting in the creation of a thorough literature review. In addition, the secondary goals that were specified were also achieved. The study allowed us to identify the writers who have published the most and those who have had the greatest impact on this subject with the highest number of citations. Results indicate that the United States and Canada have a well-established track record of research on SDG 5 and 11. However, India and Saudi Arabia have lately achieved noteworthy advancements in this domain. Moreover, the study revealed that the retrieved research papers often referenced terms associated with sustainability, community, design, transportation, and mobility.

Based on these findings, most SDG 5 and 11 research using a smart city approach concentrates on comprehending and advocating sustainability principles, tackling social problems, devising inclusive solutions, and enhancing transportation for women and commuting requirements. In addition, the report emphasized an increasing interest among scholars in health and climate in connection with SDGs 5 and 11. Nevertheless, the analysis also uncovered the need for more progress in developing a robust connection between SDG 5 and 11 from the perspective of smart cities. The authors propose more investigation into the impact of smart urban settings at the urban level to promote gender equality. For example, consider incorporating intelligent urban green areas in this context. Furthermore, the research highlights the need to examine female urban managers' involvement in smart

cities to evaluate the possibility of achieving gender equality in smart city administration.

The study found a notable deficiency in the existing body of research about the ability of smart city systems to enhance gender equality. This region needs more exploration in future studies. Hence, it is recommended that more investigation be conducted in this domain, with researchers specifically examining the significance and potential of smart cities in enhancing gender equality. Furthermore, this study has encountered difficulties like the omission of verifying the Web of Science database and the absence of practical examination of the correlation between smart cities and gender equality. However, we offer a thorough analysis of Sustainable Development Goals 5 and 11, explicitly examining smart cities and highlighting the present developments in this area.

Many cities face shortages in financial and technical resources essential for effectively implementing smart technologies; inconsistent policies and governance structures obstruct coordinated efforts to achieve SDGs in smart city initiatives.

This analysis highlights significant gaps in the literature and underscores the necessity for empirical research demonstrating successful applications of gender-sensitive policies in smart cities. Using examples from prominent metropolitan centers, we promote a more inclusive urban design strategy emphasizing gender equity. This study offers vital insights into the nexus between smart sustainable cities and gender equality; however, it is imperative to make these findings accessible and relevant for practitioners and policymakers. The findings from our bibliometric research and case studies ought to guide urban stakeholders in their decision-making processes. Urban designers and legislators can apply the found trends and effective programs to carry out gender-sensitive strategies in projects of smart cities. Strategies shown in case studies such as Barcelona and Dammam will help stakeholders create inclusive urban environments that meet the various requirements of all people—especially underprivileged groups.

A significant restriction is omitting the Web of Science database from our bibliometric analysis. While we employed the Scopus database for its broad coverage and high-quality data, facilitating a thorough examination of pertinent literature, the omission of the Web of Science may have limited the comprehensiveness of our evaluation. We defend our choice based on Scopus's benefits in covering multidisciplinary research relevant to our study; yet, we admit that adding the Web of Science might have improved our analysis by revealing more studies clarifying this important junction. Future research should use many databases to have a thorough awareness of the body of knowledge on smart sustainable cities and gender equality.

## Author contributions

AA: Formal analysis, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. KL: Formal analysis, Investigation, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing. HA: Data curation, Formal analysis, Validation, Writing – review & editing. AO: Formal analysis, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. CC: Project administration, Writing – review & editing.

## Funding

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

## Publisher's note

## References

Abbas, A. F., Jusoh, A., Mas' od, A., Alsharif, A. H., and Ali, J. (2022). Bibliometrix analysis of information sharing in social media. *Cogent Busin. Managem.* 9:2016556. doi: 10.1080/23311975.2021.2016556

Abdel-Razek, S. A. (2021). "Governance and SDGs in smart cities context," in *Smart Cities and the un SDGs* (London: Elsevier), 61–70.

Abdullah, K. H., Roslan, M. F., Ishak, N. S., Ilias, M., and Dani, R. (2023). Unearthing hidden research opportunities through bibliometric analysis: a review. *Asian J. Res. Educ. Soc. Sci.* 5, 251–62. doi: 10.55057/ajress.2023.5.1.23

Abrishami, M., and Chamberlain, B. (2023). Comparing transportation metrics to measure accessibility to community amenities. *J. Digital Landsc. Archit.* 8, 342–50. doi: 10.14627/537740037

Adebayo, P., Ndinda, C., and Ndhlovu, T. (2022). South African cities, housing precarity and women's inclusion during COVID-19. *Agenda* 36, 16–28. doi: 10.1080/10130950.2022.2057027

Adibhesami, M. A., Karimi, H., Sepehri, B., and Parvanehdehkordi, A. (2024a). "Enhancing health outcomes through city information modeling (CIM): a case study of Sydney, Australia," in *City Information Modelling* (Cham: Springer), 33–62. doi: 10.1007/978-981-99-9014-6_3

Adibhesami, M. A., Karimi, H., Sepehri, B., Sharifi, A., and Nazarian, M. (2024b). Effect of urban design on mental health during the COVID-19 pandemic, Mahabad, Iran. *Cities Health.* 2024, 1–14. doi: 10.1080/23748834.2024.2334144

Adibhesami, M. A., Karimi, H., Sharifi, A., Sepehri, B., Bazazzadeh, H., Berardi, U., et al. (2022). Optimization of urban-scale sustainable energy strategies to improve citizens' health. *Energies* 16:119. doi: 10.3390/en16010119

Allen, C., Metternicht, G., and Wiedmann, T. (2018). Initial progress in implementing the Sustainable Development Goals (SDGs): a review of evidence from countries. *Sustain. Sci.* 13, 1453–67. doi: 10.1007/s11625-018-0572-3

Al-Rashid, M. A., Nahiduzzaman, K. M., Ahmed, S., Campisi, T., and Akgün, N. (2020). Gender-responsive public transportation in the Dammam metropolitan region, Saudi Arabia. *Sustainability* 12:9068. doi: 10.3390/su12219068

Álvarez-Miño, L., and Montoya, R. T. (2022). Taxonomy for citizen actions on public health and climate change: a proposal. *Rev. Saude Publica.* 55:119. doi: 10.11606/s1518-8787.2021055003823

Anderson, C. C., Denich, M., Warchold, A., Kropp, J. P., and Pradhan, P. (2022). A systems model of SDG target influence on the 2030. Agenda for sustainable development. *Sustain Sci.* 17, 1459–72. doi: 10.1007/s11625-021-01040-8

Aparisi-Cerdá, I., Ribó-Pérez, D., Gomar-Pascual, J., Pineda-Soler, J., Poveda-Bautista, R., García-Melón, M., et al. (2024). Assessing gender and climate objectives interactions in urban decarbonisation policies. *Renew. Sustain. Energy Rev.* 189:113927. doi: 10.1016/j.rser.2023.113927

Arora, N., and Arora, M. (2022). Bibliometric analysis: effect of vitamin d in adolescent girls with polycystic ovary syndrome (2005-2022). *Int. J. Health Sci.* 33, 8459–76. doi: 10.53730/ijhs.v6nS3.8004

Asaad, A., Ibrahim, A., El Seoud, T. A., and Abdel-Moneim, N. M. (2024). An integrated toolkit for equality in daily urban mobility in saudi arabia: advancing gender mobility indicators. *Renew. Energy Sustain. Dev.* 10:782. doi: 10.21622/resd.2024.10.1.782

Asteria, D., Jap, J. J. K., and Utari, D. (2020). A gender-responsive social innovation for the sustainable smart city in Indonesia and beyond. *J. Int. Womens. Stud.* 21, 193–207. Available at: https://vc.bridgew.edu/jiws/vol21/iss6/12

Baghezza, R., Bouchard, K., and Gouin-Vallerand, C. (2022). "Recognizing the age, gender, and mobility of pedestrians in smart cities using a CNN-BGRU on thermal images," in *Proceedings of the 2022 ACM Conference on Information Technology for Social Good (GoodIT '22)* (New York, NY: Association for Computing Machinery), 48–54. doi: 10.1145/3524458.3547235

Bamwesigye, D., and Hlavackova, P. (2019). Analysis of sustainable transport for smart cities. *Sustainability* 11:2140. doi: 10.3390/su11072140

Barnes, J. L. (2021). "Designing resilient cities that work for women, too," in *The Demography of Disasters: Impacts for Population and Place* (Springer), 169–87. doi: 10.1007/978-3-030-49920-4_9

Bevilacqua, C., Sohrabi, P., Hamdy, N., and Mangiulli, F. (2023). Mapping connections between neighborhoods in response to community-based social needs. *Sustainability* 15:4898. doi: 10.3390/su15064898

Bibri, S. E., and Krogstie, J. (2020). The emerging data–driven Smart City and its innovative applied solutions for sustainability: the cases of London and Barcelona. *Energy Inform.* 3:5. doi: 10.1186/s42162-020-00108-6

Bingöl, E. S. (2022). "Citizen participation in smart sustainable cities," in *Research Anthology on Citizen Engagement and Activism for Social Change* (Hershey, PA: IGI Global), 967–87. doi: 10.4018/978-1-6684-3706-3.ch052

Buss, P. M., Fonseca, L. E., Galvão, L. A. C., Fortune, K., and Cook, C. (2016). Health in all policies in the partnership for sustainable development. *Revista Panamericana de Salud Pública.* 40, 186−91. Available at: https://www.scielosp.org/pdf/rpsp/2016.v40n3/186-191/en

Buttazzoni, A., Veenhof, M., and Minaker, L. (2020). Smart city and high-tech urban interventions targeting human health: an equity-focused systematic review. *Int. J. Environ. Res. Public Health.* 17:2325. doi: 10.3390/ijerph17072325

Campisi, T., Georgiadis, G., and Basbas, S. (2022). "Developing cities for citizens: supporting gender equity for successful and sustainable urban mobility," in *International Conference on Computational Science and Its Applications* (Cham: Springer), 410–22.

Castelo, S., Antunes, L., and Ashrafuzzaman, M. (2024). The impact of the climate crisis on gender inequality. Looking to the frontlines in search of priorities for policy. *Front. Sustain. Cities.* 6:1304535. doi: 10.3389/frsc.2024.1304535

Chan, J. J., and Chye, S. W. C. (2023). Impact of smart city initiatives on urban planning strategies in Singapore: an in-depth analysis of technology-driven solutions and their influence on sustainable development and quality of life. *J. Strat. Managem.* 7, 11–21. doi: 10.53819/81018102t4200

Chan, P., Gulbaram, K., and Schuetze, T. (2023). Assessing urban sustainability and the potential to improve the quality of education and gender equality in Phnom Penh, Cambodia. *Sustainability* 15:8828. doi: 10.3390/su15118828

Dalu, M. T. B., and Manyani, A. (2020). "Gender inclusivity and development in South African public urban spaces," in *Urban Geography in South Africa: Perspectives and Theory*, eds. R. Massey, A. Gunter (Cham: Springer), 239–50. doi: 10.1007/978-3-030-25369-1_15

Dankevych, V. Y., Kamenchuk, T. O., Kononova, O. Y., Nadtochii, I. I., and Ohor, H. M. (2020). Strategic planning for sustainable development of states: administration aspect. *Int. J. Managem.* 11, 511–522. Available at: https://ssrn.com/abstract=3601609

Datta, A. (2021). Gender, urban spaces and gendered resistances: towards inclusive and fear free cities in India. Reflections on *21st Century Human Habitats in India: Felicitation Volume in Honour of Professor MH Qureshi.* 327–43. doi: 10.1007/978-981-16-3100-9_13

Datta, A., and Thomas, A. (2022). Curating# AanaJaana [# ComingGoing]: Gendered authorship in the 'contact zone'of Delhi's digital and urban margins. *Cult Geogr.* 29, 233–52. doi: 10.1177/1474474021993415

de Miguel González, R., and Sebastián-López, M. (2022). Education on sustainable development goals: geographical perspectives for gender equality in sustainable cities and communities. *Sustainability* 14:4042. doi: 10.3390/su14074042

East, M. (2022). Bridging the urban planning gender gap–in search of policy coherence between Sustainable Development Goals 5 and 11. *Rozwój Regionalny i Polityka Regionalna.* 60, 71–86. doi: 10.14746/rrpr.2022.60s.07

Ebron, K. T., and Andenoro, A. C. (2023). "Empowering women in leadership: a transformational approach to redefining healthcare in developing African contexts," in *African Leadership: Powerful Paradigms for the 21st Century* (Leeds: Emerald Publishing Limited), 47–60.

Ellili, N. O. D. (2024). Bibliometric analysis of sustainability papers: evidence from Environment, Development and sustainability. *Environ Dev Sustain.* 26, 8183–209. doi: 10.1007/s10668-023-03067-6

Evans, J., Pregnolato, M., Rogers, C. D. F., Harris, J. A., and Topping, D. (2024). Environmental data, governance and the sustainable city. *Front. Sustain. Cities.* 5:1355645. doi: 10.3389/frsc.2023.1355645

Eyieyien, O. G., Idemudia, C., Paul, P. O., and Ijomah, T. I. (2024). The impact of ICT projects on community development and promoting social inclusion. *Int. J. Eng. Res. Dev.* 20, 300–310.

Feng, Y., Huang, C., Song, X., and Gu, J. (2023). Assessing progress and interactions toward SDG 11 indicators based on geospatial big data at prefecture-level cities in the yellow river Basin between 2015 and 2020. *Remote Sens.* 15:1668. doi: 10.3390/rs15061668

Fernanda Medina Macaya, J., Ben Dhaou, S., and Cunha, M. A. (2021). "Gendering the Smart Cities: Addressing gender inequalities in urban spaces," in *Proceedings of the 14th International Conference on Theory and Practice of Electronic Governance (ICEGOV '21)* (New York, NY: Association for Computing Machinery), 398–405. doi: 10.1145/3494193.3494308

German, S., Metternicht, G., Laffan, S., and Hawken, S. (2023). Intelligent spatial technologies for gender inclusive urban environments in today's smart cities. *Intellig. Environm.* 2023, 285–322. doi: 10.1016/B978-0-12-820247-0.00012-6

Gulati, G., Lohani, B. P., and Kushwaha, P. K. (2020). "A novel application Of IoT in empowering women safety using GPS tracking module," in *2020 Research, Innovation, Knowledge Management and Technology Application for Business Sustainability (INBUSH)* (Greater Noida: IEEE), 131–7.

Gunluk-Senesen, G. (2021). Wellbeing gender budgeting to localize the UN SDGs: examples from Turkey. *Public Money Managem.* 41, 554–60. doi: 10.1080/09540962.2021.1965402

Gupta, S., and Degbelo, A. (2023). "An empirical analysis of ai contributions to sustainable cities (SDG 11)," in *The Ethics of Artificial Intelligence for the Sustainable Development Goals* (Cham: Springer), 461–84.

Gutiérrez Mozo, M. E. (2020). Engendering Cities: Designing Sustainable Urban Spaces for All, eds. S. de Madariaga and M. Neuman (Abingdon and New York: Routledge), 334.

Hettiarachchi, H. (2022). "SDG 11: challenges and the way forward," in *SDG11, Sustainable Cities and Communities* (Lonaon: Routledge), 171–8. doi: 10.4324/9781003205975-9

Hussain, S., Hussain, E., Saxena, P., Sharma, A., Thathola, P., Sonwani, S., et al. (2024). Navigating the impact of climate change in India: a perspective on climate action (SDG13) and sustainable cities and communities (SDG11). *Front. Sustain. Cities.* 5:1308684. doi: 10.3389/frsc.2023.1308684

Hysa, B., Zdonek, I., and Karasek, A. (2022). Social media in sustainable tourism recovery. *Sustainability* 14:760. doi: 10.3390/su14020760

Itair, M., Shahrour, I., and Hijazi, I. (2023). The use of the smart technology for creating an inclusive urban public space. *Smart Cities.* 6, 2484–98. doi: 10.3390/smartcities6050112

Kauzya, J. M. (2020). "African local governments and cities in the implementation of the 2030 agenda to achieve sustainable development goals," in *Reflections on African Cities in Transition: Selected Continental Experiences. Advances in African Economic, Social and Political Development*, eds. P. S. Reddy, H. Wissink (Cham: Springer), 119–46. doi: 10.1007/978-3-030-46115-7_6

Keitsch, M. M. (2022). "Sensitizing Nepalese students for gender mainstreaming in sustainable planning and design," in *Gender and the Sustainable Development Goals* (London: Routledge), 99–114.

Küfeoglu, S. (2022). "SDG-11: sustainable cities and communities," in *Emerging Technologies: Value Creation for Sustainable Development* (Cham: Springer), 385–408.

Kusumastuti, R. D., Rouli, J., Trialdi, L., and Safitri, R. (2022). "Improving urban resilience during covid-19 pandemic by implementing smart city initiatives: a case of Tangerang City, Indonesia," in *IOP Conference Series: Earth and Environmental Science* (Bristol: IOP Publishing), 012082.

Laumann, F., von Kügelgen, J., Uehara, T. H. K., and Barahona, M. (2022). Complex interlinkages, key objectives, and nexuses among the Sustainable Development Goals and climate change: a network analysis. *Lancet Planet Health*. 6, e422–30. doi: 10.1016/S2542-5196(22)00070-5

Lee, J. H., Wu, M. Y., Liu, C. Y., and Chuang, Y. H. (2017). "Design of smart shopping wall using hand gesture and facial image recognition," in *Proceedings of the 2nd International Conference on Biomedical Signal and Image Processing (ICBIP '17)* (New York, NY: Association for Computing Machinery), 13–7. doi: 10.1145/3133793.3133803

Lindkvist, C. (2024). Gendered mobility strategies and challenges to sustainable travel—patriarchal norms controlling women's everyday transportation. *Front. Sustain. Cities* 6:1367238. doi: 10.3389/frsc.2024.1367238

Liu, A., Lu, Y., Gong, C., Sun, J., Wang, B., Jiang, Z., et al. (2023). Bibliometric analysis of research themes and trends of the co-occurrence of autism and ADHD. *Neuropsychiatr. Dis. Treat*. 985–1002. doi: 10.2147/NDT.S404801

Lynch, C. R. (2020). Unruly digital subjects: social entanglements, identity, and the politics of technological expertise. *Digital Geography Soc*. 1:100001. doi: 10.1016/j.diggeo.2020.100001

Maalsen, S., Wolifson, P., and Dowling, R. (2023). Gender in the Australian innovation ecosystem: planning smart cities for men. *Gender, Place and Cult*. 30, 299–320. doi: 10.1080/0966369X.2022.2053068

Mancebo, F. (2020). Smart city strategies: time to involve people. comparing Amsterdam, Barcelona and Paris. *J. Urban*. 13, 133–52. doi: 10.1080/17549175.2019.1649711

Manzoor, M. A., Hassan, S. U., Muazzam, A., Tuarob, S., and Nawaz, R. (2023). Social mining for sustainable cities: thematic study of gender-based violence coverage in news articles and domestic violence in relation to COVID-19. *J. Ambient Intell. Humaniz. Comput*. 14, 14631–42. doi: 10.1007/s12652-021-03401-8

Memić, B., Avdagić-Golub, E., Kosovac, A., and Muharemović, E. (2023). "Estimating urban air quality according to sustainable development goal 11," in *International Conference "New Technologies, Development and Applications."* (Cham: Springer), p. 659–66.

Mensah, J. (2019). Sustainable development: meaning, history, principles, pillars, and implications for human action: literature review. *Cogent. Soc. Sci*. 5:1653531. doi: 10.1080/23311886.2019.1653531

Mishra, A., Nanda, P., Speizer, I. S., Calhoun, L. M., Zimmerman, A., Bhardwaj, R., et al. (2014). Men's attitudes on gender equality and their contraceptive use in Uttar Pradesh India. *Reprod. Health*. 11, 1–13. doi: 10.1186/1742-4755-11-41

Mishra, S. P., Mishra, D. P., and Mishra, S. (2023). The etymology of gender violence (SDG-5) in anthropocene: India. *J. Appl. Life Sci. Int*. 26, 53–69. doi: 10.9734/jalsi/2023/v26i3607

Mohammadzadeh, Z., Saeidnia, H. R., Lotfata, A., Hassanzadeh, M., and Ghiasi, N. (2023). Smart city healthcare delivery innovations: a systematic review of essential technologies and indicators for developing nations. *BMC Health Serv. Res*. 23:1180. doi: 10.1186/s12913-023-10200-8

Mohimi, A., and Esmaeily, A. (2024). Spatiotemporal analysis of urban sprawl using a multi-technique approach and remote sensing satellite imagery from 1990 to 2020: Kerman/Iran. *Environ. Dev. Sustain*. 26:18033–68. doi: 10.1007/s10668-023-03378-8

Monteagudo, M. C., and Colleoni, M. P. M. (2021). TInnGo: transport innovative gender observatory. Spanish hub. Taxi case study. *Transport. Res. Procedia*. 58, 355–62. doi: 10.1016/j.trpro.2021.11.048

Morrow, K. (2018). "Gender and the sustainable development goals," in *Sustainable Development Goals* (Cheltenham: Edward Elgar Publishing), 149–72.

Mostofi, H. (2022). The frequency use and the modal shift to ICT-based mobility services. *Resources, Environm. Sustainab*. 9:100076. doi: 10.1016/j.resenv.2022.100076

Nesti, G. (2019). Mainstreaming gender equality in smart cities: theoretical, methodological and empirical challenges. *Inform. Polity*. 24, 289–304. doi: 10.3233/IP-190134

Ngang, C. C. (2021). "Urban landownership and the right to sustainable development for women in Africa," in *Land Issues for Urban Governance in Sub-Saharan Africa*, ed. Home (Cham: Springer), 89–102. doi: 10.1007/978-3-030-52504-0_6

Ngulube, L., Thelma, C. C., Gilbert, M. M., Sylvester, C., Mpolomoka, D. L., Mulenga, D. M., et al. (2024). Gender equality and economic growth: a case of Lusaka District, Zambia. *Asian J. Educ. Social Stud*. 50, 181–96. doi: 10.9734/ajess/2024/v50i71455

Noori, N., Hoppe, T., and Jong, D. (2020). M. Classifying pathways for smart city development: Comparing design, governance and implementation in Amsterdam, Barcelona, Dubai, and Abu Dhabi. *Sustainability*. 12:4030. doi: 10.3390/su12104030

Nugent, R., Bertram, M. Y., Jan, S., Niessen, L. W., Sassi, F., Jamison, D. T., et al. (2018). Investing in non-communicable disease prevention and management to advance the Sustainable Development Goals. *Lancet*. 391, 2029–35. doi: 10.1016/S0140-6736(18)30667-6

Othman, A., Al Mutawaa, A., Al Tamimi, A., and Al Mansouri, M. (2023). Assessing the readiness of government and semi-government institutions in qatar for inclusive and sustainable ICT accessibility: introducing the MARSAD tool. *Sustainability* 15:3853. doi: 10.3390/su15043853

Owais, M., Sumabrata, J., and Yusuf, N. (2024). Gender-based service quality evaluation of multimodal public transportation in DKI Jakarta. *Smart City*. 4:3. doi: 10.56940/sc.v4.i2.3

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., et al. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 372:n71. doi: 10.1136/bmj.n71

Pirra, M., Kalakou, S., Carboni, A., Costa, M., Diana, M., Lynce, A. R. A., et al. (2021). preliminary analysis on gender aspects in transport systems and mobility services: Presentation of a survey design. *Sustainability* 13:2676. doi: 10.3390/su13052676

Priya Uteng, T., and Turner, J. (2019). Addressing the linkages between gender and transport in low-and middle-income countries. *Sustainability* 11:4555. doi: 10.3390/su11174555

Puntillo, P. (2023). Circular economy business models: Towards achieving sustainable development goals in the waste management sector—Empirical evidence and theoretical implications. *Corp Soc Responsib Environ Manag*. 30, 941–54. doi: 10.1002/csr.2398

Ramani, S. V. (2022). "An introduction to SDG 11 and conceptual frameworks for transition management," in *SDG11, Sustainable Cities and Communities* (London: Routledge), 1–15.

Ramírez-Montoya, M. S., Buenestado-Fernández, M., and Ibarra-Vazquez, G. (2023). "Unlocking sustainable development goals through computational thinking: a search to inform computers education from citizen science dataset," in *Proceedings of the 2023 8th International Conference on Information and Education Innovations (ICIEI '23)* (New York, NY: Association for Computing Machinery), 41–7. doi: 10.1145/3594441.3594449

Rampaul, K., and Magidimisha-Chipungu, H. (2022). Gender mainstreaming in the urban space to promote inclusive cities. *J. Transdiscipl. Res. Southern Africa*. 18, 1–9. doi: 10.4102/td.v18i1.1163

Rauf, M. A., McCordic, C., Sgro, J., Frayne, B., and Wilson, J. (2023). Trading off sustainable development in Canadian cities: theoretical implications of SDG 11 indicator aggregation approaches. *Front. Sust. Cities* 5:1264710. doi: 10.3389/frsc.2023.1264710

Reid, M., and Simatele, M. D. (2021). Perspectives on energy insecurity and its impacts on urban livelihoods: adaptation and resilience of women in the informal sector. *Front. Sustain. Cities*. 3:706476. doi: 10.3389/frsc.2021.706476

Roberts, L. (2023). "Smart feminist cities: the case of Barcelona en Comú," in *Women Philosophers on Economics, Technology, Environment, and Gender History: Shaping the Future, Rethinking the Past*, ed. R. E. Hagengruber (Berlin; Boston, MA: De Gruyter), 137–146. doi: 10.1515/9783111051802-015

Rosa, W. E., and Hassmiller, S. B. (2020). The sustainable development goals and building a culture of health. *AJN Am. J. Nurs*. 120, 69–71. doi: 10.1097/01.NAJ.0000668772.33792.1f

Rouhi, K., Motlagh, M. S., Dalir, F., Perez, J., and Golzary, A. (2024). Towards sustainable electricity generation: evaluating carbon footprint in waste-to-energy plants for environmental mitigation in Iran. *Energy Reports*. 11, 2623–32. doi: 10.1016/j.egyr.2024.02.017

Rouhi, K., Shafiepour Motlagh, M., and Dalir, F. (2023). Developing a carbon footprint model and environmental impact analysis of municipal solid waste transportation: a case study of Tehran, Iran. *J. Air Waste Manage. Assoc*. 73, 890–901. doi: 10.1080/10962247.2023.2271424

Sajwani, G., and Al-Othman, H. (2023). Sustainable development: an analytical vision for smart Dubai city social policies. *Inform. Sci. Letters*. 12, 2877–89. doi: 10.18576/isl/120716

Salehi Mava, F., Khatami, S. M., and Ranjbar, E. (2022). An analysis on the factors affecting the creation of event-oriented urban public spaces case study: central part of Tehran (District 12). *Monthly Scient. J. Bagh-e Nazar*. 19:85–98.

Sankar, S. S., Sandeep, V., Visvesh, K. S., Vigneshwar, S., and Rajesh, C. B. (2022). "Design of an Efficient mobile communication and an armament system for women safety," in *Distributed Computing and Optimization Techniques: Select Proceedings of ICDCOT* (Cham: Springer), 313–23.

Saputro, D. R. S., Prasetyo, H., Wibowo, A., Khairina, F., Sidiq, K., Wibowo, G. N. A., et al. (2023). Bibliometric analysis of neural basis expansion analysis for interpretable time series (n-beats) for research trend mapping. *BAREKENG* 17, 1103–12. doi: 10.30598/barekengvol17iss2pp1103-1112

Sarachaga, J. M. D. (2021). "The contribution of Smart Cities to the achievement of the Sustainable Development Goal 11 "Sustainable cities and communities","," in *Greencities, 11° Foro de Inteligencia y Sostenibilidad Urbana: Actas del XI International Greencities Congress.* [Málaga: Palacio de Ferias y Congresos de Málaga (FCMA)], 240–50.

Sengupta, U., and Sengupta, U. (2022). SDG-11 and smart cities: contradictions and overlaps between social and environmental justice research agendas. *Front. Sociol.* 7:995603. doi: 10.3389/fsoc.2022.995603

Sharifi, A., Allam, Z., Bibri, S. E., and Khavarian-Garmsir, A. R. (2024). Smart cities and sustainable development goals (SDGs): a systematic literature review of co-benefits and trade-offs. *Cities.* 146:104659. doi: 10.1016/j.cities.2023.104659

Shulla, K., Voigt, B. F., Cibian, S., Scandone, G., Martinez, E., Nelkovski, F., et al. (2021). Effects of COVID-19 on the sustainable development goals (SDGs). *Discover Sustain.* 2, 1–19. doi: 10.1007/s43621-021-00026-x

Singh, S., and Vanka, S. (2020) "Achieving women empowerment through ICT: Case of a government initiative in India," in *Handbook of Research on New Dimensions of Gender Mainstreaming and Women Empowerment.* (Hershey, PA: IGI Global), 87–104. doi: 10.4018/978-1-7998-2819-8.ch006

Singh, Y. J. (2020). Is smart mobility also gender-smart? *J. Gend. Stud.* 29, 832–46. doi: 10.1080/09589236.2019.1650728

Sirri, L. (2024). From theory to action: a Saudi Arabian case study of feminist academic activism against state oppression. *Societies.* 14:31. doi: 10.3390/soc14030031

Sohrabi, P., Oikonomaki, E., Hamdy, N., Kakderi, C., and Bevilacqua, C. (2022). "Navigating the green transition during the pandemic equitably: a new perspective on technological resilience among Boston neighborhoods facing the shock," in *International Symposium: New Metropolitan Perspectives* (Cham: Springer), p. 285–308.

Somerville, C., and Pesantes, A. M. (2022). "SDG 5 - A long, short, and unfinished history of the journey to gender equality," in *Before the UN Sustainable Development Goals,* eds. M. Gutmann and D. Gorman (Oxford University Press). doi: 10.1093/oso/9780192848758.003.0006

Strandberg, K. (2022). "SDG 5: how to empower women in practice–anecdotal learnings and creative solutions from private companies in Sweden," in *Impact of Women's Empowerment on SDGs in the Digital Era* (Hershey, PA: IGI Global), 140–57.

Summerfield, J., and Regan, L. (2021). How can we achieve sustainable development goal-5: Gender equality for all by 2030? *Clin. Obstet. Gynecol.* 64, 415–21. doi: 10.1097/GRF.0000000000000643

Tayeng, T., Bijale, M., Ch, M., and Bhavsar, S. N. (2024). Smart city initiatives and urban governance in India: evaluating technological interventions for sustainable development. *J Appl Bioanal.* 10, 155–163. doi: 10.53555/jab.v10i2.168

Terraza, H., Orlando, M. B., Lakovits, C., Janik, V. L., and Kalashyan, A. (2020). *Handbook for Gender-Inclusive Urban Planning and Design.* Washington, DC: World Bank.

Tierney, T. F. (2019). Toronto's smart city: everyday life or google life? *Architecture_MPS.* 15:1. doi: 10.14324/111.444.amps.2019v15i1.001

Uteng, P., and Susilo, Y. (2021). Women and transport modes. *Int. Encyclop. Transpor.* doi: 10.1016/b978-0-08-102671-7.10600-1

Uteng, T. P., Singh, Y. J., and Lam, T. (2019). "Safety and daily mobilities of urban women—Methodlgies to confront the policy of "invisibility.", in *Measuring Transport Equity* (London: Elsevier), 187–202. doi: 10.1016/B978-0-12-814818-1.00012-3

Vaidya, H., and Chatterji, T. (2020). "SDG 11 sustainable cities and communities," in *Actioning the Global Goals for Local Impact. Science for Sustainable Societies,* eds. I. Franco, T. Chatterji, E. Derbyshire, and J. Tracey (Singapore: Springer). doi: 10.1007/978-981-32-9927-6_12

Vătămănescu, E. M., and Vintilă, F. (2023). "A co-occurrence scrutiny of transformational leadership, employee engagement, well-being and burnout via a bibliometric analysis," in *Proceedings of the International Conference on Business Excellence,* 1306–18.

Velasco López, J. E., and Cobo Martín, M. J. (2023). *Data-Driven Scientific Research Based on Public Statistics: a Bibliometric Perspective.*

Veloso, Á., Fonseca, F., and Ramos, R. (2024). Insights from smart city initiatives for urban sustainability and contemporary urbanism. *Smart Cities.* 7, 3188–209. doi: 10.3390/smartcities7060124

Venkatramanan, V., Shah, S., and Prasad, R. (2021). *Exploring Synergies and Trade-Offs Between Climate Change and the Sustainable Development Goals.* Cham: Springer.

Voigt, M. L. (2023). We build this city on rocks and (feminist) code: hacking corporate computational designs of cities to come. *Digital Creativity.* 34, 162–77. doi: 10.1080/14626268.2023.2205406

Wallis, A. K., Westerveld, M. F., and Burton, P. (2023). Ensuring communication-friendly green and public spaces for sustainable cities: Sustainable Development Goal 11. *Int. J. Speech Lang. Pathol.* 25, 27–31. doi: 10.1080/17549507.2022.2138544

Yadav, A., and Kumari, R. (2021). "Women and social sustainability: a critical parametric evaluation of urban settings in developing countries," in *IOP Conference Series: Earth and Environmental Science* (Bristol: IOP Publishing), 012003.

Young, A. W. (2024). *Get Thee to a Smart City: a Study on Queer Urban Planning in Seestadt Aspern.* Central European University. Available at: https://www.etd.ceu.edu/2024/young_alina.pdf

Zarie, E., Sepehri, B., Adibhesami, M. A., Pourjafar, M. R., and Karimi, H. (2024). A strategy for giving urban public green spaces a third dimension: a case study of Qasrodasht, Shiraz. *Nature-Based Solut.* 5:100102. doi: 10.1016/j.nbsj.2023.100102