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SUSTAINABLE AND SMART CITIES: CONVERGENCES, CHALLENGES AND GAPS IN GLOBAL SCIENTIFIC PRODUCTION

CIDADE SUSTENTÁVEIS E INTELIGENTES: CONVERGÊNCIAS, DESAFIOS E LACUNAS DA PRODUÇÃO CIENTÍFICA GLOBAL

CIUDADES SOSTENIBLES E INTELIGENTES: CONVERGENCIAS, RETOS Y BRECHAS EN LA PRODUCCIÓN CIENTÍFICA GLOBAL

https://doi.org/10.56238/sevened2025.029-035

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ABSTRACT

This article presents a systematic review of the literature on sustainable and smart cities, aiming to identify the main challenges and approaches addressed in scientific production between 2017 and 2025. Thirty articles indexed in the Web of Science database were analyzed, supported by thematic and bibliometric analysis. The results reveal a growing convergence between the paradigms of urban sustainability and technological innovation, but also highlight significant barriers to their implementation, especially in contexts of the Global South. Among the main obstacles are the fragmentation of indicators, institutional disarticulation, governance limitations, and the risk of exclusionary technocentric approaches. The analysis highlights the need for integrated strategies that articulate citizen participation, social equity, and the ethical use of technology. The study offers theoretical and practical insights for researchers, policymakers, and urban managers committed to more just, resilient, and sustainable cities.

Keywords: Sustainable Cities. Smart Cities. Urban Governance. Sustainability. Urban Indicators. Systematic Literature Review.

RESUMO

Este artigo apresenta uma revisão sistemática da literatura sobre cidades sustentáveis e inteligentes, com o objetivo de identificar os principais desafios e enfoques abordados na produção científica entre 2017 e 2025. Foram analisados 30 artigos indexados na base Web of Science, com apoio de análise temática e bibliométrica. Os resultados revelam uma crescente convergência entre os paradigmas da sustentabilidade urbana e da inovação tecnológica, mas também evidenciam barreiras significativas à sua implementação, especialmente em contextos do Sul Global. Entre os principais entraves estão a fragmentação de indicadores, a desarticulação institucional, as limitações de governança e o risco de abordagens tecnocêntricas excludentes. A análise aponta para a necessidade de estratégias integradas que articulem participação cidadã, equidade social e uso ético da tecnologia. O estudo oferece subsídios teóricos e práticos para pesquisadores, formuladores

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de políticas e gestores urbanos comprometidos com cidades mais justas, resilientes e sustentáveis.

Palavras-chave: Cidades Sustentáveis. Cidades Inteligentes. Governança Urbana. Sustentabilidade. Indicadores Urbanos. Revisão Sistemática da Literatura.

RESUMEN

Este artículo presenta una revisión sistemática de la literatura sobre ciudades sostenibles e inteligentes, con el objetivo de identificar los principales desafíos y enfoques abordados en la producción científica entre 2017 y 2025. Se analizaron treinta artículos indexados en la base de datos Web of Science, con apoyo de análisis temático y bibliométrico. Los resultados revelan una creciente convergencia entre los paradigmas de la sostenibilidad urbana y la innovación tecnológica, pero también destacan barreras significativas para su implementación, especialmente en contextos del Sur Global. Entre los principales obstáculos se encuentran la fragmentación de indicadores, la desarticulación institucional, las limitaciones de gobernanza y el riesgo de enfoques tecnocéntricos excluyentes. El análisis destaca la necesidad de estrategias integradas que articulen la participación ciudadana, la equidad social y el uso ético de la tecnología. El estudio ofrece perspectivas teóricas y prácticas para investigadores, formuladores de políticas y gestores urbanos comprometidos con ciudades más justas, resilientes y sostenibles.

Palabras clave: Ciudades Sostenibles. Ciudades Inteligentes. Gobernanza Urbana. Sostenibilidad. Indicadores Urbanos. Revisión Sistemática de la Literatura.

1 INTRODUCTION

In recent decades, the concept of sustainable cities has emerged as a central axis in discussions on urban development, in the face of the environmental, social, and economic challenges that cities face on a global scale. Urban sustainability involves practices that seek to balance economic growth, social inclusion, and environmental conservation, promoting the well-being of current populations without compromising future generations (BIBRI; KROGSTIE, 2020). This approach has become indispensable in the face of the disorderly growth of cities, the pressure on natural resources, and growing social inequality (SHAO; MIN, 2025).

At the same time, the advancement of technology has boosted the concept of smart cities, which combine digital innovation with urban governance and sustainability. These cities integrate information and communication technologies (ICTs) into urban management, optimizing public services, monitoring resources, and fostering citizen participation (ZHANG et al., 2023). The integration between the paradigms of sustainability and smart cities forms the model of sustainable and smart cities, considered a strategic alternative to contemporary urban challenges (BIBRI; KROGSTIE, 2017). This model seeks to promote more resilient, efficient, and inclusive urban development, reconciling economic growth, environmental preservation, and social well-being. From this convergence, a new perspective of city planning and management emerges, capable of responding to the complex demands of the twenty-first century based on data, technological innovation and sustainability principles.

However, the effective implementation of these cities faces several structural, technical and political barriers. Studies point to the lack of integration between public policies and technological strategies, the scarcity of standardized indicators, as well as difficulties related to participatory governance and inequality in access to urban solutions (CHOI; SONG, 2022; PEAR TREE; AZAMBUJA, 2022). Although there has been progress in certain regions, many initiatives remain fragmented or restricted to specific contexts.

In this context, it is necessary to critically understand what are the main obstacles to the effective applicability of sustainable and smart city models. From this, the following research question is proposed: What are the main obstacles identified by recent scientific literature for the implementation of sustainable and smart cities in the different urban realities of the world?

To answer this question, this study aims to critically analyze recent scientific production on sustainable and smart cities, identifying the main thematic approaches, methodological approaches, indicators used, and gaps in the national and international literature indexed in

the Web of Science database, in the period from 2017 to 2025. The proposed systematization intends to contribute to the theoretical and practical advancement of the area, providing subsidies for researchers, public managers and public policy makers interested in understanding and implementing effective strategies of sustainable urbanism.

2 METHODOLOGY

2.1 SYSTEMATIC REVIEW OF THE LITERATURE

The present Systematic Literature Review (RSL) was carried out with the objective of mapping and critically analyzing the recent scientific production on sustainable and smart cities, identifying the main obstacles, thematic approaches, methodological approaches and gaps existing in the field. The RSL is justified in view of the growing complexity and theoretical dispersion related to the theme, being particularly relevant to identify recurrent patterns, analytical divergences, and paths for future investigations.

In recent years, there has been a significant growth in scientific production focused on sustainable and smart cities. This movement highlights not only the increased interest on the part of the academic community, but also the urgency imposed by the practical challenges of sustainable urban development. However, this advance has resulted in a dispersed panorama, marked by diverse theoretical approaches, different methodologies, and definitions that do not always converge. In view of this, a systematic review of the literature is indispensable, both to organize and consolidate the knowledge already produced and to critically examine its contributions, points of convergence and gaps that still exist.

The choice of RSL as a methodological approach is based on its ability to produce a rigorous, transparent, and reasoned synthesis of the state of the art of a scientific field, as highlighted by Okoli (2019). In addition, its application contributes to the advancement of knowledge by offering an analytical basis for new investigations. To ensure rigor, transparency, and methodological reproducibility, the process adopted followed two central references: the guidelines of the PRISMA 2020 protocol (Page et al., 2021) and the conceptual and practical model for conducting systematic reviews proposed by Okoli (2019). The combination of these approaches makes it possible to align the process both with internationally consolidated scientific dissemination standards and with the methodological depth required in autonomous reviews, such as this one.

In addition to the PRISMA guidelines and Okoli's theoretical-methodological model, the conduct of this review also dialogues with the reflection proposed by Collins and Fauser (2005) on the importance of reconciling the strengths of systematic and narrative reviews.

The authors argue that, although systematic reviews are more appropriate for specific scope issues, because they adopt explicit, transparent, and reproducible methods, they can also benefit from narrative approaches, which bring greater fluidity, thematic breadth, and interpretative connection between the data. According to the authors, well-conducted reviews should seek a balance between methodological rigor and communicative clarity, presenting understandable and useful results to readers, without losing analytical soundness. Thus, this RSL was developed based on the technical robustness required by the scientific field, but attentive to the need to present a critical and intelligible synthesis of the challenges and obstacles faced by cities in the transition to more sustainable and intelligent urban models.

2.2 APPROACH AND OBJECTIVE

The starting point of this review was the precise delimitation of its central objective and the guiding question, in accordance with the guidelines proposed by Okoli (2019). From this, the following central question was formulated: "What are the main challenges pointed out by the recent scientific literature for the implementation of sustainable and smart cities in different urban contexts around the world?"

Based on this, the central objective of the RSL was to critically analyze the theoretical and empirical body published between 2017 and 2025, with a specific focus on scientific production indexed in the Web of Science database, in order to identify the main thematic approaches addressed, the methodologies used, the indicators used in the measurement of sustainability or urban intelligence, as well as the challenges and recurring gaps. With this, it seeks not only to organize the knowledge already consolidated, but also to highlight weaknesses and opportunities for the advancement of research on sustainable and smart cities.

2.3 SEARCH AND SELECTION STRATEGY

The elaboration of the search strategy aimed to capture the widest possible variety of relevant studies, prioritizing the convergence between the concepts of sustainable cities and smart cities. The Web of Science (WoS) database was chosen, widely recognized for its academic solidity and international coverage, which enabled access to a wide range of journals specialized in urban planning, sustainability, governance and technological innovation.

The search was carried out by selecting publications between January 2017 and July 2025, an interval that corresponds to the time frame defined for the review, as it is a

representative window of recent and contemporary publications on the subject. The search string formulation combined core descriptors with Boolean operators, applying them to the title, abstract, and keyword fields. The expression used was: ("smart city" OR "smart cities") AND ("sustainable city" OR "sustainable cities" OR "sustainable urban development") AND ("sustainable city" OR "smart city") AND ("sustainable smart city OR sustainable smart cities"). This combination was developed based on Okoli's (2019) recommendation to build sensitive and specific search strategies that balance the scope and relevance of the results.

The screening and selection process of articles followed the four main steps described in the PRISMA 2020 model (Page et al., 2021): identification, screening, eligibility, and inclusion as described in Figure 1. Initially, 881 articles were found. Reading the titles resulted in the exclusion of 534 articles because they did not align directly with the scope of the review. There were 347 articles, which were submitted to an analysis of keywords and abstracts. Of these, 259 were excluded because they presented technical or empirical approaches disconnected from the central theme. The remaining 88 articles were evaluated through analytical reading of their abstracts, which led to the exclusion of 43 more studies. Finally, 45 articles were read in full, resulting in the final selection of 31 articles considered relevant and consistent with the defined criteria.

During all stages of document analysis, the four criteria for documentary evaluation proposed by Scott (1990 apud BIBRI and KROGSTIE, 2020) were followed, ensuring the validity and integrity of the sources used:

1. Authenticity: the evidence gathered is genuine and of verifiable origin;

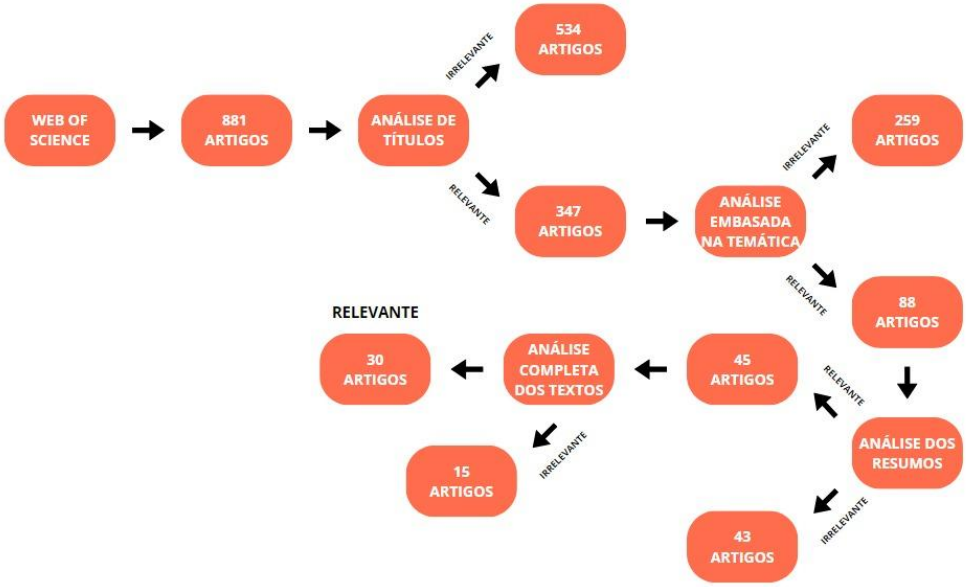
2. Credibility: the data do not present distortions or visible methodological errors;

3. Representativeness: the selected material is typical and faithfully reflects the universe of studies on the subject;

4. Meaning: the contents analyzed are clear, understandable and offer information relevant to the objectives of the review.

Figure 1

Article selection flowchart



Source: The authors.

2.4 DATA EXTRACTION, CATEGORIZATION AND ANALYSIS

After the final selection of the 31 articles, each one was read in full, with the subsequent extraction of relevant data for qualitative analysis. The extraction was systematized in an analysis matrix created in Microsoft Excel, where each article was classified based on previously defined analytical variables: year of publication, country of the author(s), methodological approach used, main thematic approaches (environmental, social, economic, technological, political-institutional), type of indicators applied and main obstacles reported to the implementation of sustainable and smart cities.

The categorization of the data followed a logic of qualitative thematic analysis, based on the principles of manual coding according to Okoli's (2019) guidelines. Categories and subcategories were created based on the recurrence of the themes present in the articles, allowing the identification of patterns, convergences and relevant gaps.

The support for the analysis process also included the use of the RStudio software, through the Bibliometrix package, especially in the bibliometric diagnosis stage. This analysis served as a complementary basis to reinforce the thematic structure of the articles and map the temporal and geographical distribution of scientific production, without prejudice to the interpretative analysis of the contents.

Finally, the results of the categorization and analysis were organized to allow a structured interpretation of the field, subsidizing the next sections of the article with a consistent empirical and theoretical basis.

2.5 DATA EXTRACTION, CATEGORIZATION AND ANALYSIS

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The support for the analysis process also included the use of the RStudio software, through the Bibliometrix package, especially in the bibliometric diagnosis stage. This package, developed for the R language, provides a set of tools aimed at quantitative research in scientometrics and bibliometrics, integrating the main methods of analysis and resources for mapping networks of co-The authors., co-citation and co-occurrence of keywords. As highlighted by Aria and Cuccurullo (2017), Bibliometrix allows the construction and interpretation of scientific networks, offering a robust framework for systematic reviews based on quantitative evidence. The application of this tool in this review made it possible to complement the qualitative analysis with visualizations and indicators that contributed to the recognition of patterns in scientific production on sustainable and smart cities.

Finally, the results of the categorization and analysis were organized to allow a structured interpretation of the field, subsidizing the next sections of the article with a consistent empirical and theoretical basis.

3 RESULTS AND DISCUSSION

3.1 APPROACHES TO SUSTAINABLE AND SMART CITIES IN THE LITERATURE

Recent academic production has been increasingly dedicated to the articulation between the concepts of sustainable cities and smart cities, suggesting distinct but

complementary approaches to face the complex challenges of today's urban areas. The analyzed publications indicate that sustainable cities continue to play a normative and strategic role in the field of public policies, while smart cities emerge as practical instruments, strongly linked to the application of innovative technologies.

Authors such as Tahvilzadeh, Montin, and Cullberg (2021) highlight that the discourse on urban sustainability fulfills several functions, operating not only as a technical guideline, but as a political and symbolic instrument. In this sense, they state that "sustainability, as a concept, is capable of mobilizing different agents, shaping policies and legitimizing certain urban practices".

In the same axis, Bibri and Krogstie (2020) propose an integrated model of sustainable smart cities, in which urban intelligence, based on data and digital technologies, acts as a means to achieve the broader objectives of sustainability. For the authors, this model needs to incorporate social, technological, institutional, and ecological dimensions in an articulated way, and it is essential that technology serves social equity and environmental resilience.

In the field of evaluation and analysis models, a significant variety of approaches can be observed in the literature. A relevant example is the study by Abu-Rayash and Dincer (2021), which presents an integrated system of indicators to measure urban sustainability in smart city contexts. These indicators include areas such as energy, mobility, waste management, environment and governance, offering support both for the monitoring of urban performance and for the development of public policies more aligned with the principles of sustainability.

Alignment with the Sustainable Development Goals (SDGs), especially SDG 11, is recurrent in the analyzed base. Bibri and Krogstie (2021) highlight the importance of linking urban intelligence to the achievement of the SDGs, highlighting that "the collection, integration, and analysis of large volumes of urban data can promote more effective decisions aimed at sustainability".

With regard to the most recurrent theoretical approaches, the predominance of systemic and interdisciplinary perspectives stands out. The studies explore urban sustainability at different scales, ranging from specific actions at the local level to commitments made at the global level, such as climate goals and international agreements. Themes such as urban resilience, spatial justice, and smart governance appear recurrently, evidencing an effort to integrate technological advances with principles of social equity and active participation of the population.

The role of urban innovation is also emphasized by Caragliu and Del Bo (2019), who analyze how smart city policies affect innovation in urban centers. The authors empirically demonstrate that there is a positive correlation between the level of digitalization of cities and their innovative performance, suggesting that technology can be a lever for sustainable solutions when guided by well-structured public strategies.

However, the review also highlights gaps and asymmetries in the way concepts are operationalized. In several studies, there is a predominance of technocentric approaches, focusing on infrastructure and Information and Communication Technologies (ICTs), to the detriment of social and territorial aspects. Azambuja (2022) reinforces this point by highlighting that, in contexts of the Global South, political limitations, scarcity of data, and unequal access to technologies are critical barriers to the effectiveness of sustainable and smart projects.

In summary, the studies examined point to the importance of an integrated approach to the multiple dimensions that make up the urban space. It is evident that the understanding of sustainable and smart cities requires a broader vision, which goes beyond isolated perspectives. The combination of technological innovation, citizen participation in governance, and commitment to social justice is fundamental to dealing with the complex urban challenges that mark the twenty-first century.

3.2 MAIN CHALLENGES AND OBSTACLES TO THE IMPLEMENTATION OF SUSTAINABLE AND SMART CITIES

The analysis of the scientific literature carried out in this systematic review highlights a series of obstacles that still limit the effective implementation of sustainable and smart cities. These obstacles take different forms, ranging from institutional and technical deficiencies to political and social challenges. In addition, its manifestation varies according to the territorial context, the stage of development and the degree of maturity of the urban policies adopted.

Among the most frequently mentioned obstacles is the lack of alignment between international indicator standards and the practical conditions faced by cities, especially those located in developing countries. As pointed out by Huovila, Bosch and Airaksinen (2019), there is still a proliferation of initiatives that use different sustainability indicators, without clear guidelines regarding the choice of the most appropriate parameters or the appropriate time for their application. This disordered diversity compromises the possibility of consistent comparisons and makes it difficult to develop strategies that are truly adjusted to local specificities.

Another relevant challenge refers to the persistent difficulties in the integration between natural elements and technological solutions. The research carried out by Chu et al. (2023) shows that, although many cities adopt discourses focused on environmental sustainability, initiatives that effectively articulate green infrastructure with smart urban technologies are still limited. There is a lack of alignment between the areas in charge of environmental management and those focused on technological innovation, which reduces the potential of digital solutions to promote concrete benefits for urban ecosystems.

The challenge of inter-institutional collaboration and integrated governance is also strongly present. Van de Meene, Bettini, and Head (2020) highlight that many local governments lack administrative structures capable of promoting lasting collaborative actions, both horizontally (across sectors) and vertically (across levels of government). This leads to siloed, poorly scalable, and low-systemic impact initiatives.

From the point of view of urban strategies and integrated planning, the research by Moscarelli and Kleiman (2017) points to a history of fragmentation between key areas of urban policy in Brazil, such as housing, mobility, and sanitation. Such fragmentation compromises the implementation of sustainable urban policies in a systemic manner, since each policy tends to operate with low coordination and conflicting visions.

An additional challenge concerns the limited feasibility of nature-based solutions (NBS) in contexts situated in the Global South. According to Castaldo et al. (2025), although these solutions have great potential to boost sustainability and promote environmental justice, they still face significant obstacles, such as the scarcity of financial resources, the insufficiency of local technical training, and the lack of guidelines compatible with realities marked by urban informality. The effective adoption of these strategies depends on institutional changes that are still at an early stage.

In the field of innovation governance, Al Sharif and Pokharel (2022) warn of the risks associated with over-reliance on technocentric approaches, which often prioritize monitoring and automation technologies over inclusive social policies. This can lead to worsening urban inequalities and the exclusion of vulnerable groups from the benefits promised by smart cities.

Shao and Min (2025) add to this discussion the problem of the inadequacy between smart city models and the existing institutional structure in many countries. Often, local governments lack the human, financial, and regulatory resources necessary to absorb international models and transform them into effective local strategies, which leads to low implementation or symbolic results.

Finally, Pereira and Azambuja (2021) argue that addressing these challenges requires the development of strategic roadmaps that combine a long-term vision with effective mechanisms for social participation and strengthening governance. Such instruments have the potential to drive institutional transformations by establishing defined objectives, timelines, and performance indicators capable of aligning technological innovation, environmental sustainability, and public management at the local level.

3.3 BIBLIOMETRIC ANALYSIS OF SCIENTIFIC PRODUCTION ON SUSTAINABLE AND SMART CITIES

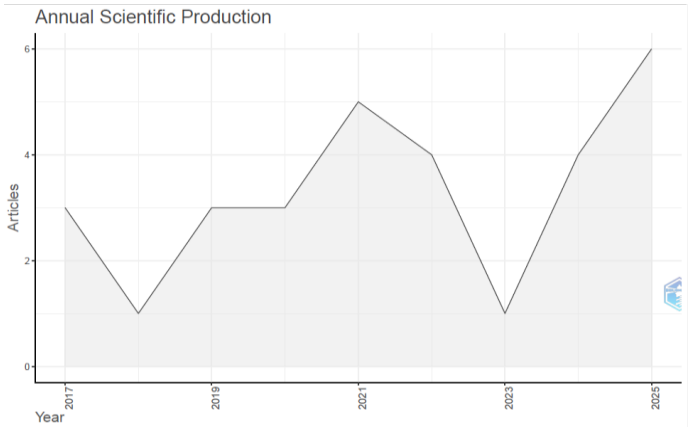
The bibliometric analysis of this Systematic Literature Review (RSL) was carried out with the support of the Bibliometrix package in the RStudio environment, as developed by Aria and Cuccurullo (2017), who highlight the importance of using bibliometrics to map trends and patterns in emerging areas of scientific knowledge. Such an approach allows us to identify not only the volume of production, but also the collaboration networks, emerging themes, and the concentration of citations between authors and institutions.

3.3.1 Scientific Production Over the Years

Figure 2 illustrates the evolution of scientific production between 2017 and 2025. There is a steady growth in publications from 2019 onwards, with a sharp peak in 2021 and 2025. Such growth follows the maturation of debates on urban sustainability on a global scale, especially after the COVID-19 pandemic, which intensified discussions on urban resilience, digitalization, and socio-environmental justice (Karal & Soyer, 2024; Bibri, 2021).

Figure 2

Annual Scientific Production Graph



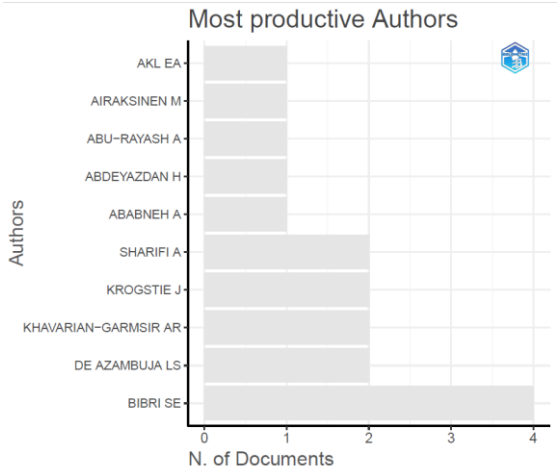
Source: The authors.

3.3.2 Most Productive and Most Cited Authors

In Figure 3, the most productive authors in the sample stand out. Simon Elias Bibri leads by a wide margin, being responsible for several studies focused on urban models of smart and sustainable cities (Bibri, 2021; Sharifi et al., 2024). Other notable authors include Sharifi, Allam, and Khavarian-Garmsir, who reinforce the connection between smart cities and the Sustainable Development Goals (SDGs) in the environmental, social, and governance dimensions (Sharifi et al., 2024; Sharifi, Amirzadeh & Khavarian-Garmsir, 2025).

Figure 3

Most productive authors by number of publications



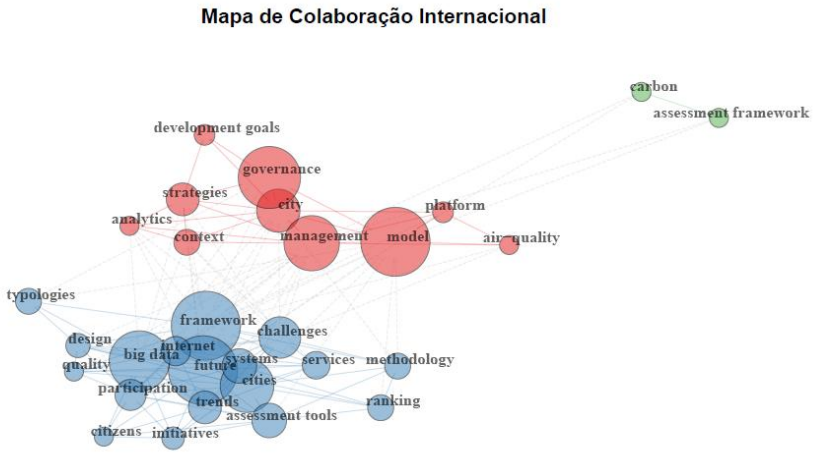
Source: The authors.

3.3.3 International collaboration

Figure 4 presents the map of international collaboration between the countries that contributed to the scientific production on sustainable and smart cities. The density of the connections between the nodes in the graph indicates that there is strong cooperation between several countries, especially among those with a greater tradition in urban and technological research. The growing articulation between countries at different levels of development also demonstrates the search for shared solutions, adaptable to different contexts, as pointed out by Tahvilzadeh et al. (2017) when analyzing sustainability discourses in urban governance, and Goodarzi & Berghorn (2025), when proposing evaluative models based on residential satisfaction as a criterion for effectiveness in sustainable communities. As highlighted by Aria and Cuccurullo (2017), this type of analysis allows the identification of collaborative trends and centers for the dissemination of knowledge, which is essential to understand the internationalization of the debate on urban sustainability.

Figure 4

Map of international collaboration between countries



Source: The authors.

3.3.4 Most Frequently Asked Keywords

Figure 5 shows the keywords with the highest recurrence in the analyzed articles. Terms such as "smart cities", "sustainable", "urban development", "sustainability", "governance" and "development" stand out, which occupy a central position in the records. These findings dialogue with what has already been discussed in the literature. Abu-Rayash and Dincer (2021), for example, emphasize the relevance of consistent indicators to guide effective public policies, while Zeng et al. (2024) explore how the Internet of Things (IoT) can contribute to the promotion of sustainability in the urban environment.

Figure 5

Most productive authors by number of publications

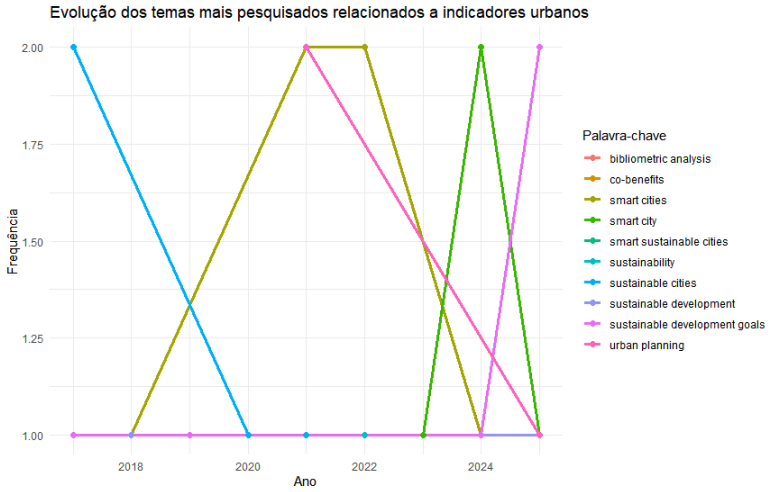
Source: The authors.

3.3.5 Analysis of Emerging Indicators and Trends

Based on the data in Figure 6, there is an advance in the use of integrated indicators to evaluate the performance of smart cities. Recent literature criticizes the excessive fragmentation between existing indicators and calls for a system that is more coherent and sensitive to regional realities (Parra-Pulido et al., 2025; Huovila et al., 2019). Studies such as that of Shams & Alkhalifa (2025) also point to the need for accessible tools for measuring sustainability in buildings, reflecting practical and scalable concerns.

Figure 6

Evolution of the most researched topics related to urban indicators



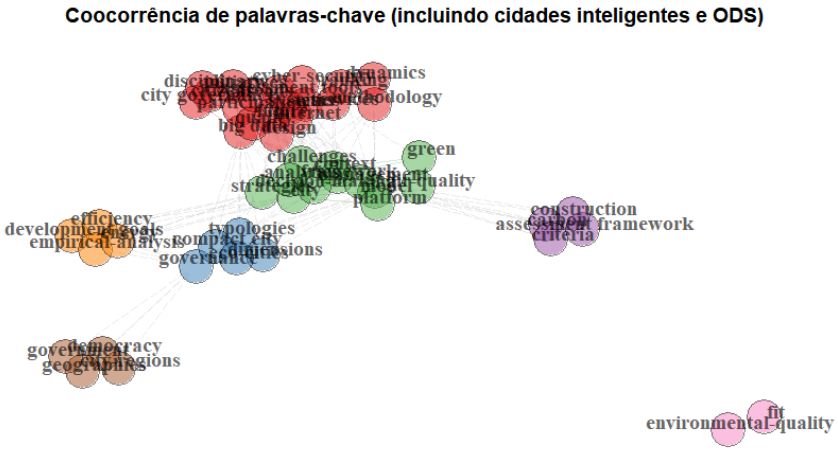
Source: The authors.

3.3.6 Conceptual Connectivity between Smart Cities and SDGs

Figure 7 indicates the theoretical convergence between the concepts of smart city and sustainable development. Studies such as those by Blasi, Ganzaroli, & De Noni (2022) show that the articulation between digital innovation and the SDGs is still incipient, requiring greater strategic articulation by local and international governments. In a complementary way, Angelidou et al. (2018) highlight that the use of urban applications needs to be accompanied by structured policies of inclusion and social impact.

Figure 7

Keyword correlation (including smart cities and SDGs)



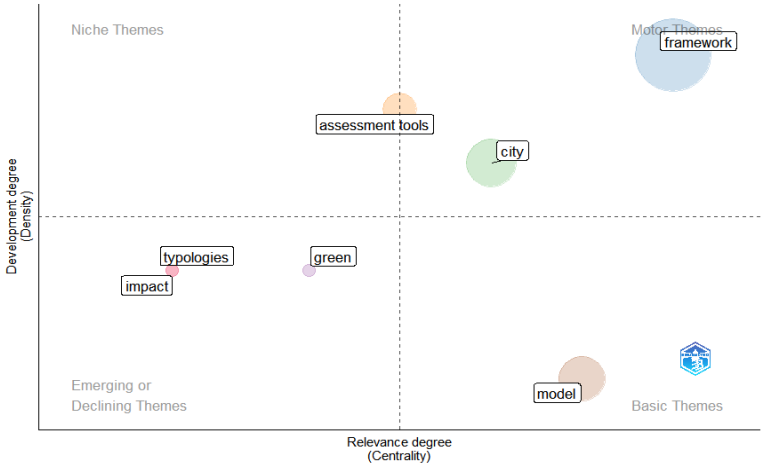
Source: The authors.

3.3.7 Thematic Challenges and Gaps

Figure 8 shows the main themes addressed and the gaps identified. The most recurrent challenges refer to governance, data standardization, social exclusion, limitation in the use of ICTs, and scarcity of tools adapted to the context of the Global South (Castaldo et al., 2025; Mercher, 2019; Lnenicka et al., 2022). This justifies the importance of more sensitive regional analyses, such as the one proposed by Galiano et al. (2021) on urban mobility.

Figure 8

Recurring themes and gaps by thematic cluster



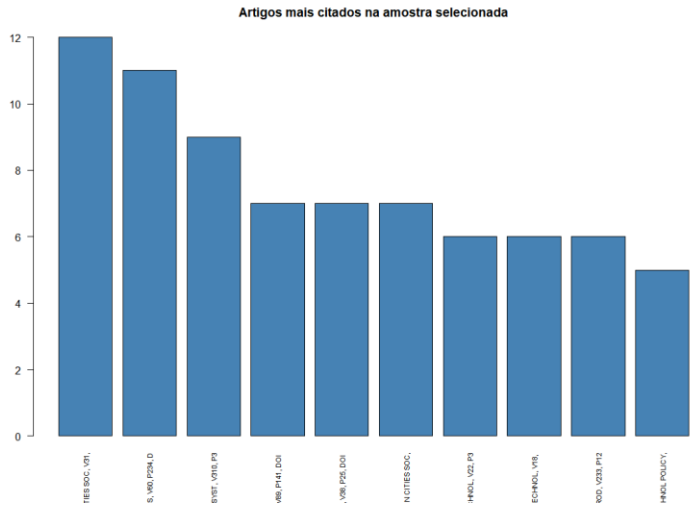
Source: The authors.

3.3.8 Citation Dynamics and Academic Impact

Finally, Figure 9 shows the most cited articles in the analyzed database. The study by Bibri (2021) emerges as the most referenced, followed by Sharifi et al. (2024) and Abu-Rayash & Dincer (2021), reinforcing its centrality in the consolidation of theoretical models applicable to urban practice. The scholarly impact of these contributions underpins the importance of systematic and integrated research for the formulation of future urban strategies.

Figure 9

Most cited articles in the selected sample



Source: The authors.

4 CONCLUSION

The present systematic review of the literature allowed us to map, classify and critically reflect on the main approaches adopted by recent scientific production around the concept of sustainable cities. From the analysis of the selected studies, it was observed that the debate on urban sustainability has become progressively more multidimensional and intersectoral, incorporating elements of smart urban planning, participatory governance, performance indicators, digital technologies and the Sustainable Development Goals (SDGs).

Among the most significant findings, the consolidation of the understanding that sustainability in cities should not be restricted to environmental or technological aspects, but rather consider the structural complexity of contemporary urban centers, which includes social inequalities, territorial governance, mobility, energy security, housing, and digital inclusion. In this sense, the study by Abu-Rayash and Dincer (2021) was directly explanatory

in proposing an integrated model of performance indicators for smart cities, covering domains such as energy, society, infrastructure, economy, and resilience. Such an approach highlights the importance of systematic and comparable diagnoses between different urban contexts, enabling not only the continuous monitoring of progress, but also the formulation of more effective public policies.

In addition, authors such as Bibri and Krogstie (2021) point to the emergence of data-driven smart sustainable cities, in which the intensive use of technologies such as artificial intelligence and big data can enhance structural transformations in governance and urban planning models. However, the literature also warns of risks associated with technocentrism and the dehumanization of cities, reinforcing the need for inclusive and socially sensitive policies — a gap that is still evident in some of the publications analyzed.

On the other hand, the work of Balusamy et al. (2023) broadens the debate by addressing the role of the metaverse in future urban planning, pointing out potential benefits and trade-offs in articulating with the SDGs. The use of these immersive technologies suggests innovative ways to co-create more participatory urban spaces, but it also demands a critical look at accessibility and digital equity.

Finally, the bibliometric analysis carried out showed a substantial growth in scientific production on sustainable cities over the last decade, with emphasis on authors and countries from the Global North. Even so, there is a clear need to expand Latin American and African protagonism in this field, both in empirical and theoretical terms. Gaps related to the integration between public policies, standardized indicators and local sustainability practices are also evidenced, aspects that need to be deepened in future studies.

Therefore, this systematic review offers a robust theoretical basis for researchers, public managers, and urban planners interested in promoting more sustainable, resilient, and just cities. The convergence between data science, institutional innovation, and social engagement is an essential strategic guideline to face the urban challenges of the twenty-first century.

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