

CITIZEN PERCEPTION IN SMART CITIES: A SYSTEMATIC REVIEW

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Abstract

This systematic review examines how citizen perception and its manifestations have been investigated and operationalized in smart city research. Although citizens are increasingly recognized as central to smart urban development, the literature remains dispersed across disciplines, constructs, methods, and practical objectives. Following the PRISMA 2020 statement, 450 records were identified, and 75 peer-reviewed journal articles published through December 2025 were included. The studies were analyzed through an integrative framework comprising Research Focus, Methodological Operationalization, and Research Contributions. The results show that Social Sciences and Urban Studies dominate the disciplinary profile, while Participatory Governance and Citizen Involvement constitute the main functional and behavioral orientations. The distribution of perception-related constructs reveals substantial conceptual fragmentation, with a large number occurring only once. Survey research and multiple-method designs predominate, and most contributions take the form of explanatory models or assessment frameworks directed toward governance, technology, and urbanism. The review identifies an asymmetry between the importance attributed to citizens and the limited attention devoted to their substantive influence, rights, and lived experiences. It proposes an analytical structure that clarifies how citizen perceptions are formed and translated into broader urban outcomes. These findings provide a basis for advancing more coherent and inclusive approaches to citizen-centered smart city research and practice.

Keywords: citizen perception; smart cities; urban sustainability; systematic literature review.

1. INTRODUCTION

Smart city research has expanded from a predominantly technological agenda toward a multidisciplinary field encompassing governance, sustainability, public services, urban experience, and diverse assessment indicators (Angelidou, 2015; Mora et al., 2017; Tezza et al., 2024). This transition reflects growing recognition that technological availability alone does not determine the legitimacy or effectiveness of smart city initiatives. Institutional trust, government responsiveness, citizen participation, and perceived value influence whether urban technologies and policies are accepted, used, and regarded as beneficial (Alamoudi et al., 2022; Landa Oregi et al., 2025). Citizens are consequently represented not only as users, but also as evaluators, participants, and potential co-producers of urban transformation.

Despite this recognition, citizen perception remains conceptually fragmented (Esashika et al., 2021). Studies employ constructs such as satisfaction, trust, awareness, acceptance, engagement, influence, perceived quality of life, and perceived benefits to describe different aspects of citizens' relationships with smart city initiatives (Alzougool & Banna, 2025; Cho & Maeng, 2024; Hakeem & Sulphrey, 2025). These constructs often belong to different analytical levels: some measure subjective evaluations, others capture knowledge, intentions, relational agency, or experienced outcomes. Their coexistence without a shared structure restricts comparison and obscures how the field operationalizes the citizen perspective.

This review aims to explain how citizen perception and its manifestations have been investigated, operationalized, and translated into scientific and practical contributions in smart city research (Jeong & Kim, 2020). Citizen perception is defined as the process through which citizens interpret and evaluate smart city initiatives and the attributes that give those initiatives meaning or value. The review addresses three questions: (1) in which functional contexts and through which citizen-related phenomena has perception been investigated; (2) how has it been operationalized through constructs and methods; and (3) what scientific and practical contributions have resulted? Unlike syntheses restricted to a particular technology, service, or participatory mechanism, this study integrates Research Focus, Methodological Operationalization, and Research Contributions within a common analytical framework applied to 75 studies.

2. LITERATURE REVIEW AND ANALYTICAL FRAMEWORK

Citizen-centered smart city research challenges approaches that define urban intelligence primarily through infrastructure, data, and technological efficiency. Critical studies show that the language of participation may coexist with institutional arrangements that constrain citizens' influence, frame them primarily through consumption, or limit their capacity to shape the issues and values underlying data-driven urban development (Baibarac-Duignan & de Lange, 2021; Cardullo & Kitchin, 2019). Other studies demonstrate that citizen-based assessments reveal dimensions of urban performance and perceived quality of life that cannot be captured through infrastructure and technological indicators alone (Ban et al., 2022; Dhenge & Nimbarte, 2024). Citizen perception is therefore both an object of inquiry and a source of knowledge for assessing urban interventions (Jeong & Kim, 2020).

The literature nevertheless mobilizes the citizen perspective through distinct representations. Technology adoption research predominantly approaches citizens as prospective users and examines the conditions shaping their acceptance of urban technologies (Nam & Pardo, 2011; Sepasgozar et al., 2019). Other studies represent citizens through their evaluations of urban initiatives, their involvement in participatory processes, or their exercise of agency and citizenship (Preston et al., 2020). Across these perspectives,

perceptual, evaluative, participatory, and rights-oriented constructs capture different dimensions of the citizen–smart city relationship. Although these traditions overlap, they are not conceptually equivalent, as each foregrounds different citizen roles and consequently different objects of measurement and outcomes.

The Analytical Framework for Citizen Perception in Smart Cities (Table 1) was developed to enable comparability across these differences. Research Focus identifies the Functional Domain in which perception is investigated and the Behavioral Domain representing the citizen-related phenomenon. Methodological Operationalization captures the research method, approach, study nature, and primary Perception-related Construct. Research Contributions identifies the Nature of Contribution, Impact Area, and Practical Implications. The framework does not assume causal relationships among these dimensions; rather, it maps how particular contexts and citizen roles become associated with specific constructs, methods, and forms of contribution.

TABLE 1 - ANALYTICAL FRAMEWORK FOR CITIZEN PERCEPTION IN SMART CITIES

Dimension	Components	Analytical purpose
Research Focus	Functional Domain; Behavioral Domain.	Identifies where perception is studied and the citizen-related phenomenon examined.
Methodological Operationalization	Method, Approach, and Study Nature; Perception-related Construct.	Shows how the citizen perspective is conceptualized and investigated.
Research Contributions	Nature of Contribution; Impact Area; Practical Implications.	Examines how citizens' knowledge translates into scientific and practical outputs.

Source: Own processing.

3. RESEARCH METHODOLOGY

The review followed PRISMA 2020 (Page et al., 2021), while Cooper's taxonomy (Cooper, 1988) was used to delimit its focus, objective, organization, perspective, audience, and coverage. ScienceDirect, Web of Science, Scopus, SpringerLink, and EBSCOhost were selected because their combined coverage encompasses the urban, social, environmental, governance, and information-technology literatures relevant to smart cities.

The final search update was completed in December 2025, with no lower publication-date limit. The shared conceptual query combined three groups: (smart city OR smart cities) AND (citizen OR resident OR public) AND (perception OR perspective). The groups were refined through preliminary exploratory searches to capture recurrent manifestations of citizen perception (Booth et al., 2016; Snyder, 2019). Database-specific syntax, wildcards, and field codes were adapted to each interface. Searches targeted titles, abstracts, and keywords and, where permitted by the interface, full text.

Eligible publications were peer-reviewed journal articles in English reporting theoretical or empirical research examining citizen perception in the strict sense or distinct perception-related manifestations framed as citizens' subjective relationships with smart city initiatives. These constructs encompass complementary cognitive, evaluative, intentional, relational, and experiential dimensions. To be included, they had to be explicitly theorized, measured, or analyzed in relation to citizens' subjective orientation toward a smart city initiative. Studies addressing objective urban conditions, institutional arrangements, or observed behavior without a citizen-centered subjective focus were excluded. Conference papers, chapters, editorials, book reviews, grey literature, unavailable full texts, and studies limited to technological, computational, engineering, or infrastructural aspects without a citizen perspective were also excluded. Table 2 summarizes the protocol and eligibility criteria.

TABLE 2 - REVIEW PROTOCOL AND ELIGIBILITY CRITERIA

Element	Specification
Review scope	Citizen perception and its evaluative, cognitive, attitudinal, intentional, relational, and experiential manifestations in smart city contexts.
Coverage	Database inception through December 2025; ScienceDirect, Web of Science, Scopus, SpringerLink, and EBSCOhost.
Core search groups	("smart city" OR "smart cities") AND ("citizen" OR "resident" OR "public") AND ("perception" OR "perspective"); syntax and field codes adapted by database.
Inclusion criteria	Peer-reviewed journal articles in English; studies examining citizen perception or a related subjective construct within a smart city initiative; sufficient full-text information.
Exclusion criteria	Non-journal and grey literature; technology-only studies; unrelated contexts; unavailable or analytically insufficient full texts.
Final corpus	75 articles selected from 450 identified records following PRISMA screening.

Source: Own processing.

The searches returned 450 records: ScienceDirect (n = 23), Web of Science (n = 182), Scopus (n = 93), SpringerLink (n = 121), and EBSCOhost (n = 31). Records were imported into Zotero, and 313 duplicates were removed using DOI matching supplemented by manual title inspection. The remaining 137 titles and abstracts were screened against the predefined criteria; 48 were excluded. Eighty-nine full texts were assessed for eligibility, and 14 failed to meet the criteria, producing a final corpus of 75 studies. Figure 1 documents the identification, screening, eligibility, and inclusion stages.

A standardized extraction matrix was defined before synthesis. For each study, it recorded authorship, year, title, abstract, journal, disciplinary orientation, functional and behavioral domains, method, approach, study nature, perception-related constructs, nature of contribution, impact area, and practical implications. The same fields and definitions were applied to all 75 studies, creating a direct audit trail between the source articles and every frequency reported in the results.

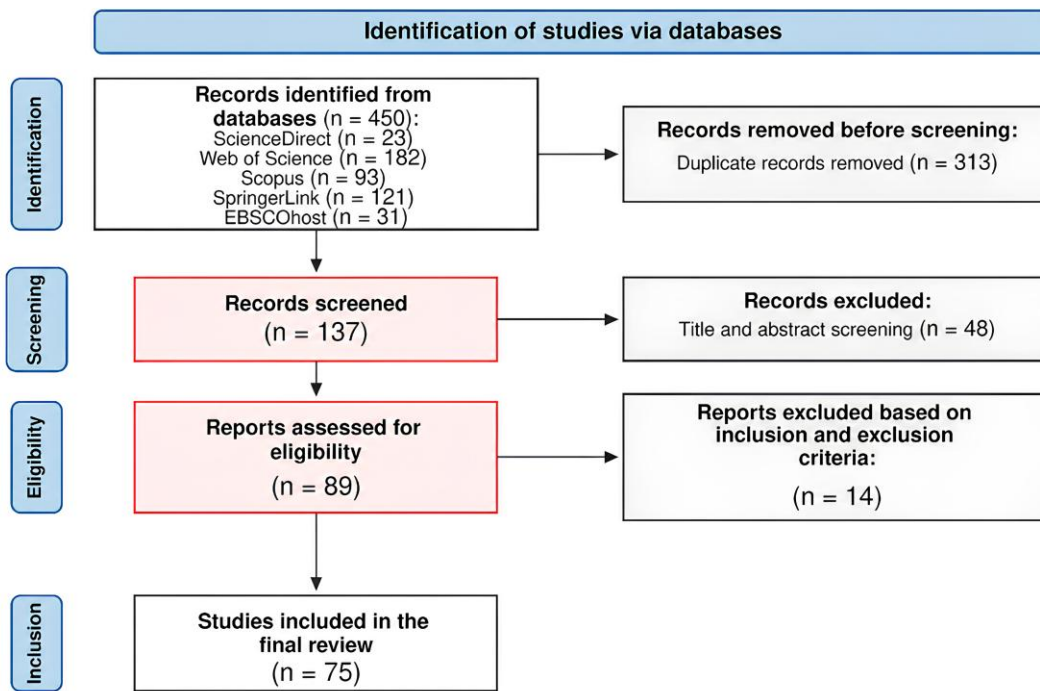


FIGURE 1 - PRISMA FLOW DIAGRAM

Source: Own processing based on PRISMA 2020 (Page et al., 2021).

Coding followed a hybrid deductive-inductive procedure informed by systematic content analysis (Krippendorff, 2019). The three overarching dimensions of the proposed Analytical Framework were defined a priori, whereas their internal categories were refined through iterative examination of titles, abstracts, and full texts. Each study was assigned one predominant category per framework component based on its research focus, theoretical framework, methodological design, findings, practical implications, and principal contribution. When a study addressed multiple constructs or outcomes, priority was given to the construct performing the primary analytical role. Equivalent labels were standardized, resulting in 40 perception-related constructs. These constructs were inductively organized into five perceptual dimensions, Cognitive, Technology, Empowerment, Experiential, and Environmental, through comparison of their original definitions, operationalizations, and analytical roles. The constructs were classified using the criteria established for these dimensions, and inter-coder reliability was assessed using Krippendorff's alpha for nominal data. Disagreements were subsequently re-examined against the full texts and resolved through consensus. This analytical classification was developed to improve comparability across studies rather than to constitute an empirically validated typology.

To map the thematic structure of the corpus, keyword co-occurrence was analyzed in VOSviewer 1.6.21 using all author-provided keywords, full counting, LinLog/modularity normalization, and a minimum threshold of three occurrences (Van Eck & Waltman, 2010). Terms were retained as reported in the

source publications; therefore, the map represents the vocabulary of the corpus rather than a thesaurus-normalized network.

Furthermore, to examine how the reviewed studies were distributed across the components of the proposed Analytical Framework, an alluvial diagram was generated. The diagram visualized the distribution of studies across Functional Domains, Behavioral Domains, Perceptual Dimensions, and Nature of Contribution. Contingency analyses were conducted using the R statistical software to determine whether the pathways displayed in the diagram reflected systematic associations rather than random category distributions. Given the presence of sparse cells, statistical significance was assessed through Monte Carlo simulations. Cramér's V was calculated to estimate the strength of association between Perceptual Dimensions and each remaining framework component.

4. RESULTS AND DISCUSSION

4.1. *Bibliometric and disciplinary profile*

Publication activity was sporadic until 2018 and expanded consistently from 2019, reaching 15 studies in 2023 and 16 in 2025. The pattern indicates a recent consolidation of citizen perception as a recognizable smart city research agenda rather than a mature and stable field. Publication remains dispersed across journals, with no dominant outlet. Sustainability, Cities, Urban Planning, and Sustainable Cities and Society are the most recurrent venues, while many journals contribute only one article.

The disciplinary distribution reinforces this dispersion. Social Sciences account for 36% of the corpus and Urban Studies for 26.7%, followed by Cross-disciplinary journals (14.7%), Information Technology (12%), and Environmental Studies (10.7%). Citizen perception is thus situated mainly within debates on governance, institutions, social relations, and urban development, while technology and environmental disciplines supply complementary adoption and sustainability perspectives. This breadth encourages interdisciplinary dialogue but also facilitates the transfer of constructs without common definitions or measurement practices.

Keyword co-occurrence analysis (Figure 2) reveals a thematic structure strongly centered on citizen participation, engagement, governance, and smart cities. The density and central position of these terms indicate that the literature has predominantly framed the citizen perspective through institutional arrangements, participatory mechanisms, and governance processes. In this context, citizens are commonly examined in relation to their involvement in planning, decision-making, and the implementation of smart city initiatives, rather than in relation to the meanings they attribute to urban transformation.

Trust, awareness, and public utility occupy less dense areas of the network. These themes address citizens' relational evaluations, cognitive understanding, and assessments of the utility of smart city

initiatives. Their weaker connections suggest that they have not yet formed a consolidated theoretical core within the field. Ethics and policy appear at the periphery of the network, indicating that normative, political, and critical perspectives remain marginal to the dominant research agenda. Overall, the network reflects a literature that privileges the functional role of citizens in governance and participation, while giving comparatively less attention to the cognitive, evaluative, experiential, and critical dimensions of citizen perception.

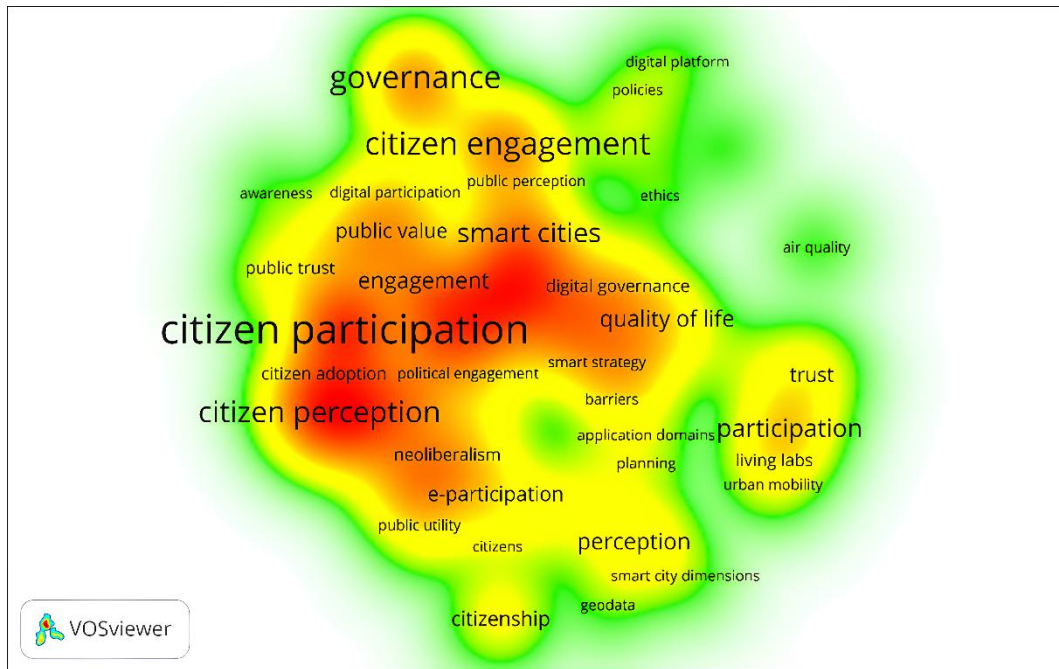


FIGURE 2 - KEYWORD CO-OCCURRENCE DENSITY MAP

Source: Own processing using VOSviewer.

Overall, the map indicates that citizen perception is investigated primarily in relation to participation mechanisms, governance arrangements, and engagement, whereas issues concerning rights, lived experience, power asymmetries, and the broader social implications of smart urban development receive more fragmented attention. This thematic imbalance is consistent with critical studies questioning whether citizen-centered discourse necessarily translates into substantive influence, public value, and more inclusive forms of urban governance (Cardullo & Kitchin, 2019; Lai & Cole, 2022; Przybilowicz et al., 2022).

4.2. Research focus and citizen roles

Table 3 summarizes the distribution of the 75 studies across the Functional and Behavioral Domains. Frequencies were calculated directly from the standardized coding matrix using one predominant category per study within each analytical component; consequently, percentages use $N = 75$ as their denominator and sum to 100% within each domain.

TABLE 3 - DISTRIBUTION OF STUDIES BY FUNCTIONAL AND BEHAVIORAL DOMAINS

Domain	Category	Studies (n)	% of corpus (N = 75)
Functional Domain	Participatory Governance	32	42.7
	Urban Sustainability	15	20.0
	Digital Platforms	10	13.3
	Public Services	10	13.3
	Intelligent Technologies	8	10.7
Behavioral Domain	Citizen Involvement	35	46.7
	Citizen Evaluation	23	30.7
	Citizen Adoption	9	12.0
	Citizenship	8	10.7

Source: Own processing.

Participatory Governance is the predominant Functional Domain, representing 32 studies (42.7%). This concentration indicates that citizen perception has been examined mainly as a component of governance, planning, and participatory processes, rather than as an autonomous object of inquiry. Urban Sustainability accounts for 15 studies (20%), while Digital Platforms and Public Services each account for 10 (13.3%). Together, these domains show that perceptions are commonly mobilized to assess how citizens respond to institutional initiatives and digitally mediated public interactions. Intelligent Technologies account for only eight studies (10.7%), suggesting that the literature gives comparatively less attention to citizens' perceptions of emerging technologies themselves than to their role in urban governance and sustainability.

The Behavioral Domain refers broadly to how citizens evaluate, engage with, adopt, or exercise agency within smart city initiatives, encompassing both behavioral and related evaluative, intentional, participatory, and citizenship-oriented manifestations. Within this domain, Citizen Involvement is predominant, comprising 35 studies (46.7%), followed by Citizen Evaluation with 23 (30.7%), Citizen Adoption with nine (12.0%), and Citizenship with eight (10.7%). Involvement is concentrated mainly in Participatory Governance and Digital Platforms, whereas Evaluation is more strongly associated with Urban Sustainability and Public Services. Adoption is distributed across Intelligent Technologies, Digital Platforms, and Public Services, while Citizenship is linked primarily to Participatory Governance.

The prominence of involvement demonstrates a movement beyond strictly technocentric accounts of smart cities (Cardullo & Kitchin, 2019; Przybilowicz et al., 2022), but it does not necessarily establish substantive citizen agency. Digital channels and participatory mechanisms may expand opportunities to express views and contribute to urban initiatives (Alizadeh et al., 2019; Simonofski et al., 2018) without ensuring that citizen input effectively alters objectives, priorities, or decisions (Chantry, 2023; Devine-Wright & Davies, 2023). Only five studies use Citizen Influence as the primary perception-related construct, while Citizen Control and Citizen Agency remain rare. The field therefore documents participatory opportunities more consistently than citizens' perceived capacity to shape outcomes,

reinforcing the distinction between procedural participation and substantive political influence (Baibarac-Duignan & de Lange, 2021; Mohseni, 2021).

4.3. Methods and perception-related constructs

Surveys are the most frequent method (36%), followed by studies employing multiple methods (32%). Case studies represent 9.3%, conceptual research 8%, literature reviews 6.7%, documentary analysis 5.3%, and interviews or focus groups 2.7%. Empirical research accounts for 88% of the corpus. Quantitative approaches represent 40%, qualitative approaches 37.3%, and mixed methods 22.7%. The field therefore combines measurement and contextual interpretation, but empirical accumulation has developed faster than theoretical integration.

The construct distribution makes this gap explicit. Across the reviewed studies, 40 distinct perception-related constructs were identified, demonstrating a high diversity in how citizens' perspectives are operationalized. Technology Acceptance is the most recurrent construct, appearing in seven studies (9.3%), followed by Awareness in six (8%). Satisfaction, Trust, and Citizen Influence occur in five studies each (6.7%), and Perceived Quality of Life and Value in three each (4%). Eight additional constructs occur twice, while 25 occur only once. Table 4 summarizes the recurring constructs.

TABLE 4 - RECURRING PERCEPTION-RELATED CONSTRUCTS

Perception-related construct	Studies (n)	% of corpus (N=75)
Technology Acceptance	7	9.3
Awareness	6	8.0
Satisfaction	5	6.7
Trust	5	6.7
Citizen Influence	5	6.7
Perceived Quality of Life	3	4.0
Value	3	4.0
Constructs occurring twice	16	21.3
Single-occurrence constructs	25	33.3

Source: Own processing.

Note. *Constructs occurring twice*: Perceived Benefits, Citizen Control, Citizen Empowerment, Expectations, Readiness, Sense of Gain, Perceived Service Quality, and Sustainability Perception. *Single-occurrence constructs*: AI Perception, Air Pollution Awareness, Citizen Agency, Citizen Role, Citizen Sentiment, City Smartness, Civic Engagement Attitudes, Civic Pride, Digital Rights, Flow Experience, Perceived Air Pollution Health Risk, Perceived Data Control, Policy Literacy, Political Efficacy, Risk Perception, Safety, Self-Organization, Perceived Smart City Effectiveness, Perceived Smart Governance Quality, Spirit of Place, Technology Anxiety, Territorial Smartness, Urban Decay, Perceived Urban Environmental Problems, and Willingness to Participate.

The low individual frequencies indicate that research on citizen perception is characterized by a fragmented conceptual landscape, with multiple constructs being used to capture different dimensions of citizens' experiences, evaluations, and interactions with smart city initiatives. This diversity reflects several analytical levels: cognitive capacities such as Awareness and Policy Literacy (Alzougool & Banna, 2025; Lee et al., 2024); evaluations such as Satisfaction, Perceived Service Quality, and Risk Perception (Gendel-Guterman & Billig, 2021; Lai & Cole, 2022; Zhu et al., 2022); intentions such as Technology Acceptance and Willingness to Participate (Lebrument et al., 2021; Sepasgozar et al., 2019); and

experienced outcomes such as Perceived Quality of Life and Sustainability Perception (Akbar et al., 2025; Dhenge & Nimbarte, 2024). These concepts are related but not interchangeable. Some measure citizens' interpretations or evaluations of smart city initiatives, whereas others capture cognitive capacities, behavioral intentions, relational conditions, or experienced outcomes. Treating them as equivalent manifestations of perception would obscure the specific phenomenon examined in each study. Accordingly, this review analyzes them as distinct but interrelated constructs through which the citizen perspective is operationalized in smart city research.

Informed by systematic content analysis (Krippendorff, 2019), the 40 perception-related constructs were initially organized into five perceptual dimensions through comparison of their conceptual meanings, operationalizations, and analytical functions. Table 5 presents the classification criteria established for each dimension and the final allocation of the constructs.

TABLE 5 - CLASSIFICATION CRITERIA FOR PERCEPTION-RELATED CONSTRUCTS

Perceptual dimension	Classification criterion	Perception-related constructs
Cognitive Perception	Applied when a construct represents citizens' cognitive, interpretative, or evaluative orientation toward smart city initiatives and their anticipated consequences.	Readiness; Expectations; Awareness; Trust; Value; Policy Literacy; Risk Perception; Perceived Benefits.
Technology Perception	Applied when a construct represents citizens' relationship with digital systems and technologically mediated urban initiatives.	Technology Acceptance; Perceived Service Quality; Digital Rights; Perceived Smart Governance Quality; AI Perception; Perceived Smart City Effectiveness; City Smartness; Territorial Smartness; Technology Anxiety; Perceived Data Control.
Empowerment Perception	Applied when a construct represents citizens' capacity, position, or ability to act within, influence, or shape urban decision-making processes.	Citizen Influence; Citizen Empowerment; Citizen Role; Willingness to Participate; Political Efficacy; Citizen Control; Citizen Agency; Civic Engagement Attitudes; Self-Organization.
Experiential Perception	Applied when a construct represents citizens' subjective experience of urban life or the perceived effects of smart city initiatives on everyday life.	Citizen Sentiment; Perceived Quality of Life; Satisfaction; Sense of Gain; Civic Pride; Spirit of Place; Flow Experience.
Environmental Perception	Applied when a construct represents citizens' interpretation of physical, environmental, or spatial urban conditions.	Sustainability Perception; Perceived Air Pollution Health Risk; Perceived Urban Environmental Problems; Safety; Air Pollution Awareness; Urban Decay.

Source: Own processing.

Classification was based on the meaning and function attributed to each construct in its source study rather than on its label alone. Inter-coder reliability was assessed in R statistical software by calculating Krippendorff's alpha for nominal data. The assessment yielded 85% agreement and Krippendorff's $\alpha = .814$, indicating adequate reliability. Disagreements were subsequently re-examined against the full texts, with particular attention to the constructs' original definitions, operationalizations, and primary analytical roles, and resolved through consensus. This procedure supported consistent application of the

classification criteria while preserving the theoretical meaning attributed to each construct in the original studies.

4.4. Research contributions and integrated analytical pathways

To synthesize how the citizen perspective is operationalized across the reviewed literature, the five perceptual dimensions were mapped against Functional Domains, Behavioral Domains, and Nature of Contribution. Figure 3 uses an alluvial diagram to show how the 40 perception-related constructs, classified according to the criteria presented in Table 5, are distributed across these framework components. The diagram identifies recurrent analytical configurations in the corpus and provides an integrated view of the relationships among research contexts, citizen-related phenomena, and research contributions. It represents patterns of association and does not imply causal relationships.

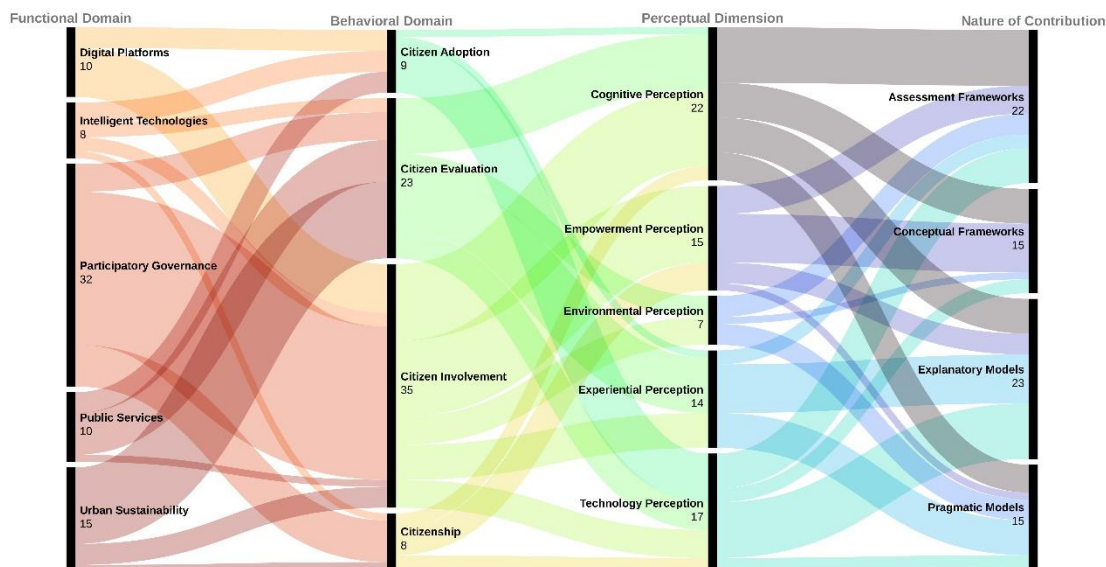


FIGURE 3 - ALLUVIAL DIAGRAM AMONG ANALYTICAL FRAMEWORK COMPONENTS

Source: Own processing using RAWGraphs.

To determine whether the pathways shown in Figure 3 reflect systematic associations rather than random allocations of coded categories, contingency analyses were conducted between Perceptual Dimensions and each remaining framework component using R software. Monte Carlo simulations with 100,000 replicates were used to obtain robust significance estimates in the presence of sparse cells. Chi-square (χ^2) tests assessed whether the observed distributions differed from those expected under random allocation, whereas Cramér's V estimated the strength of the associations.

Significant associations were identified between Perceptual Dimensions and Functional Domains, $\chi^2(16, N = 75) = 31.33, p = .011$, Cramér's V = .323; Behavioral Domains, $\chi^2(12, N = 75) = 35.37, p < .001$, Cramér's V = .396; and Nature of Contribution, $\chi^2(12, N = 75) = 22.69, p = .027$, Cramér's V = .318. The Cramér's V coefficients indicate moderate associations across the three analyses. Accordingly, the

pathways represent structured relationships within the reviewed corpus rather than patterns produced solely by the coding allocation. This pattern is particularly evident for Empowerment Perception, which was concentrated in Participatory Governance, where it appeared in 12 of its 15 studies (80.0%), and in Citizen Involvement, which accounted for 11 studies (73.3%).

Furthermore, the pathways reveal that the citizen perspective in smart city research remains largely structured around evaluative and interpretative processes. Citizens are predominantly positioned as actors who assess, understand, and respond to initiatives, whereas their capacity to shape urban transformations receives comparatively less attention. This pattern reflects a gradual shift from technology-centered research toward citizen-oriented perspectives, although technological and managerial rationales continue to shape how researchers conceptualize participation and citizenship (Cardullo & Kitchin, 2019). Across the pathways, Explanatory Models (31%) and Assessment Frameworks (29%) predominate over Conceptual Frameworks and Pragmatic Models (20% each), indicating greater emphasis on explaining and evaluating citizen-related phenomena than on theoretical integration or practical translation.

Participatory Governance emerges as the most comprehensive pathway, connecting Citizen Involvement and Citizenship mainly with Cognitive and Empowerment Perceptions. Its contributions are primarily conceptual and explanatory, linking participation, influence, and agency to Public Governance, the dominant impact area (43%) (Choo et al., 2023; Devine-Wright & Davies, 2023). Practically, this pathway supports Participation Mechanisms (23%), Public Policy Support (19%), and Citizen Empowerment (13%). However, the prominence of Cognitive Perception suggests that participation is often assessed through attitudes and willingness to engage rather than through effective shared decision-making (Lebrument et al., 2021; Remr, 2023). Thus, citizen-focused initiatives may incorporate participation while preserving limited citizen power and institutional control (Baibarac-Duignan & de Lange, 2021; Chantry, 2023). The association with Empowerment Perception signals an emerging but still underdeveloped pathway toward substantive participatory capacity (Mohseni, 2021; Pinto et al., 2022).

Urban Sustainability follows a different trajectory, primarily connecting Citizen Evaluation with Environmental and Cognitive Perceptions. The dominance of assessment frameworks positions citizens as evaluators of sustainability outcomes, environmental conditions, risks, and perceived benefits (Angarita-Lozano et al., 2025; Poyraz et al., 2025). Although this broadens sustainability research beyond technical indicators, its impact remains concentrated in Urbanism (16%), with Environment accounting for only 5%. Likewise, Environmental Monitoring accounts for just 3% of practical implications, revealing limited translation of citizens' environmental knowledge into collaborative action (Akbar et al., 2025; Dhenge & Nimbarte, 2024; Relvas et al., 2025). The weak integration of Empowerment Perception

therefore suggests that citizens are more often positioned as evaluators of sustainable transitions than as actors shaping environmental strategies.

Technology-related domains, particularly Intelligent Technologies and Digital Platforms, show the strongest relationship with Citizen Adoption and Technology Perception. Their predominantly explanatory contributions clarify responses through perceived usefulness, ease of use, readiness, and acceptance (Baldi et al., 2022; Sepasgozar et al., 2019). This pathway is closely aligned with Technology as an impact area (21%) and with Adoption Barriers (15%) as a practical implication, demonstrating how citizen knowledge is used to facilitate implementation and identify technological, institutional, and informational constraints. Yet the emphasis remains on how technological characteristics shape responses rather than how technologies reconfigure social relations, governance, and urban experience. The limited prominence of Data Ethics (8%) reinforces calls to address privacy, accountability, power asymmetries, and the distribution of benefits more explicitly (den Hartog et al., 2024).

Public Services represent an intermediary pathway between technological infrastructures and everyday experience. Their association with Citizen Evaluation, Citizen Adoption, and Experiential Perception generates assessment-oriented evidence concerning satisfaction, quality, value, and service outcomes (Ban et al., 2022; Li et al., 2022; Zhu et al., 2022). These contributions mainly affect Public Governance and translate practically into Public Policy Support and Service Improvement (9%), reducing the distance between institutional provision and citizens' needs. However, their weaker relationship with Empowerment Perception suggests that smart services are still examined more as objects of delivery, feedback, and responsiveness than as mechanisms for expanding citizen autonomy or decision-making capacity (Simonofski et al., 2018; Singh et al., 2024).

Overall, the integrated pathways show how citizen knowledge produces scientific contributions and practical outputs, but also expose persistent asymmetries. Research is comparatively effective at explaining and assessing citizen-related phenomena and using them to improve governance, technology, and urban interventions. It is less developed in producing conceptual and pragmatic models or impacts related to Social Capital (8%), Human Capital (5%), Environment (5%), and Economy (1%). Similarly, Inclusive Participation (6%), Urban Well-being (4%), and Environmental Monitoring (3%) remain peripheral practical implications. Citizens are therefore recognized more consistently as users, evaluators, and participants than as actors able to negotiate priorities and influence urban trajectories (Cardullo & Kitchin, 2019; Przybilowicz et al., 2022). Strengthening empowerment, experiential, rights-oriented, and ethical perspectives could connect explanation and assessment more directly to implementation, redistribution of influence, improved lived experience, and socially and environmentally meaningful outcomes (Angelidou et al., 2025; Pinto et al., 2022).

4.5. Theoretical, methodological, and practical implications

The main theoretical implication is that the citizen perspective in smart city research should not be treated as a single, undifferentiated phenomenon. Rather, studies should distinguish between citizen perception in the strict sense and related cognitive, technological, empowerment, experiential, and environmental constructs. This distinction reflects the diversity of constructs mobilized across the literature, including awareness and policy literacy (Alzougool & Banna, 2025; Lee et al., 2024), technology acceptance and readiness (Baldi et al., 2022; Sepasgozar et al., 2019), citizen power and participatory capacity (Mohseni, 2021; Pinto et al., 2022), perceived quality of life and service-related experiences (Dhenge & Nimbarte, 2024; Gendel-Guterman & Billig, 2021), and sustainability and environmental perceptions (Akbar et al., 2025; Poyraz et al., 2025). Organizing these constructs into conceptually distinct dimensions can reduce conceptual conflation, strengthen construct specification, and improve comparability across studies. It also provides a more coherent basis for examining how distinct forms of the citizen perspective relate to functional contexts, citizen behaviors, and the contributions generated by applied research.

Methodologically, these findings call for research designs capable of capturing the contextual specificity and conceptual diversity of citizen perception and related constructs. Qualitative approaches can identify locally meaningful experiences and interpretations, while psychometric validation, longitudinal designs, and measurement-invariance testing can assess the reliability, validity, and comparability of perception-related constructs across cities, countries, and population groups (Borba et al., 2026). Sequential mixed-methods designs are particularly suitable for integrating contextual exploration with systematic measurement (Creswell & Plano Clark, 2018). Greater integration between self-reported perceptions and evidence of institutional responses, observed participation or adoption, and social or environmental outcomes would also help distinguish subjective orientations from their antecedents, behavioral expressions, and consequences.

For practitioners, the findings suggest that citizen-centered evaluation should extend beyond satisfaction, technology uptake, and the availability of participatory mechanisms. Municipalities should assess not only how citizens evaluate technologies and services, but also whether digital platforms support clear goals, timely feedback, and an appropriate alignment between task demands and citizens' capabilities, whether citizens understand smart city initiatives, have meaningful opportunities to influence them, and perceive tangible improvements in their urban experience (Ban et al., 2022; Dhenge & Nimbarte, 2024; Borba et al., 2025). Evaluation should also address themes that remain comparatively peripheral in the literature, particularly policy literacy and the inclusion of marginalized populations (Lee et al., 2024; Mullick & Patnaik, 2025). Incorporating these considerations into planning and evaluation would support a broader assessment of whether smart city development produces meaningful, inclusive, and socially responsive urban outcomes.

5. CONCLUSIONS

This review demonstrates that citizen perception and related subjective constructs have become an increasingly visible but unevenly consolidated research agenda within the smart city literature. Research is concentrated primarily in the Social Sciences and Urban Studies, with Participatory Governance and Citizen Involvement occupying central positions. This configuration confirms the growing recognition of citizens in smart city research, but also reveals an important asymmetry: opportunities for participation are examined more consistently than citizens' substantive influence, rights, agency, and experienced outcomes (Devine-Wright & Davies, 2023; Przybilowicz et al., 2022).

Conceptual fragmentation remains a central limitation of the field. The most recurrent perception-related constructs appear in fewer than one in ten studies, while 25 constructs occur only once. Technology Acceptance constitutes a comparatively standardized trajectory within Citizen Adoption, consistent with established acceptance-based approaches to smart city technologies (Baldi et al., 2022; Sepasgozar et al., 2019), whereas Citizen Evaluation, Citizen Involvement, and Citizenship rely on more heterogeneous constructs and methodological approaches. The predominance of explanatory models and assessment frameworks, together with the concentration of impacts in governance, technology, and urbanism, further indicates that citizen perspectives are still mobilized primarily to understand, evaluate, or improve existing smart city initiatives rather than to examine citizens' capacity to shape their direction.

The proposed analytical framework addresses this fragmentation by integrating research contexts, citizen-related phenomena, theoretical constructs, methodological choices, and research contributions within a common analytical structure. More specifically, the classification of the 40 perception-related constructs into Cognitive, Technology, Empowerment, Experiential, and Environmental dimensions provides a structured basis for comparing conceptually distinct forms of the citizen perspective across the reviewed studies. This organization reflects the diversity of research addressing awareness and literacy, technology acceptance, citizen power, perceived quality of life, and environmental evaluation (Akbar et al., 2025; Dhenge & Nimbarte, 2024). Rather than imposing a universal measure of citizen perception, the framework differentiates related but non-equivalent constructs and supports greater construct specification and cumulative knowledge development in smart city research.

The review is limited by its focus on English-language publications, the selected databases and search terminology, and the classification of studies according to predominant analytical categories. Database-specific coverage may have resulted in uneven retrieval, while assigning one principal category per component necessarily simplifies multidimensional studies. The harmonization and classification of constructs involved interpretive judgment, which was addressed through explicit classification criteria, iterative comparison, full-text reassessment, consensus-based resolution of disagreements, and inter-

coder reliability assessment. Although Krippendorff's alpha indicated adequate consistency in the classification of perception-related constructs into perceptual dimensions, the resulting analytical classification requires subsequent empirical validation. Future studies should also connect self-reported perceptions with institutional responses and behavioral evidence, while devoting greater attention to citizen agency, digital rights, inclusion, and well-being (Pinto et al., 2022; Mullick & Patnaik, 2025).

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