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Digital Crowdsourcing Methods for Community Monitoring of Smart City Services: A Systematic Review

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ABSTRACT

In today's increasingly digital and interconnected world, crowdsourcing is becoming an important tool for monitoring and improving smart city services. Enhanced connectivity enables citizens to contribute local knowledge and real-time information, thereby expanding the capacity for service monitoring and strengthening transparency, accountability, and responsiveness in urban management. However, the evidence base remains fragmented, particularly in low-and middle-income contexts. This paper systematically reviews peer-reviewed literature on crowdsourcing as a form of community-based monitoring of smart city services, focusing on channel design, participation dynamics, data actionability, equity and bias, and institutional response. The search strategy was guided by PRISMA 2020 aligned protocol and was complemented by searches of relevant governance repositories. Study quality was appraised using the Mixed Methods Appraisal Tool. Twenty-four studies were synthesised, spanning issue-reporting platforms, SMS-based field experiments, volunteered geographic information and collaborative mapping, and passive social media crowdsourcing. Findings show that crowdsourcing increases informational visibility and can improve agency responsiveness. However, service quality gains remain inconsistent where reports are not actionable or institutional capacity is weak. Socio-spatial inequalities and digital divide biases also persist. Therefore, crowdsourcing should be designed as a socio-technical accountability system that integrates low-friction reporting channels, verification mechanisms, institutionalised feedback loops and bias-aware governance.

Keywords: crowdsourcing, smart city services, community-based monitoring, citizen reporting, digital governance, digitalization

INTRODUCTION

Digital transformation has become a central component of governments strategic agendas because it can enable crowd participation in monitoring smart city services. Urbanisation continues to reshape service delivery, governance and civic life. The United Nations projects that by 2050 two-thirds of the world population will be in urban areas, with the fastest absolute growth occurring in Africa and Asia (UNDESA, 2025). This demographic pressure is unfolding alongside rising citizen expectations and growing fiscal stress on city authorities. At the same time, policy is shifting toward smart governance, which harnesses digital infrastructure and data to improve the quality and inclusiveness of public services (UN-Habitat, 2024). Within this landscape, service monitoring has emerged as a key priority for city administrations. They increasingly require timely, localised and disaggregated information on infrastructure faults, including potholes and street lighting. Cities also need data on service failures such as waste collection, water outages and residents lived experiences of safety, mobility and accessibility. Traditional authoritative monitoring is often costly, slow and spatially incomplete,

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in contexts where administrative capacity is limited (Kontokosta & Hong, 2021). Against this backdrop, crowdsourcing is increasingly changing how communities monitor urban services and participate in city governance.

Crowdsourcing is understood as the outsourcing of tasks traditionally performed by designated agents to a large, undefined set of contributors via an open call (Howe, 2006; Brabham, 2013). The method has been promoted as a means to supplement scarce monitoring capacity with citizen-generated data. The transformation to participatory approaches like crowdsourcing is a means of engaging netizens in monitoring the quality-of-service delivery in rapidly evolving smart cities. Robbins (2018:182) identifies three enabling elements, that is, a motivating goal, a clearly defined crowd and a channel through which crowdsourcing is managed and mediated. The literature reports several crowdsourcing practices, including citizen reporting, participatory sensing, volunteered geographic information (VGI), civic hacking and passive crowdsourcing of social media content (Simonofski et al., 2021). Community-based monitoring (CBM) is framed not merely as data generation, but as a smart city approach that empowers residents to define, influence, monitor and act upon issues affecting their communities. The smart city concept has been defined as initiatives or approaches that effectively leverage digitalisation to boost citizen well-being and deliver more efficient, sustainable and inclusive urban services and environments as part of a collaborative, multi-stakeholder process (OECD, 2023). Complementary definitions emphasise the integration of physical, digital and social infrastructures to achieve sustainability, resilience, inclusion and human rights (ITU, 2024; UN-Habitat, 2024). Contemporary urban policy warns that technology-centric models risk deepening exclusion in the absence of deliberate attention to equity and accountability (UN-Habitat, 2024). The people-centred smart city discourse has accordingly shifted the question from "how much technology" to "which technologies, for whom, governed how", situating residents not as end-users, but as co-producers and co-evaluators of city services (Mayangsari & Novani, 2015). This shift has been reinforced by the diffusion of mobile technology, which has expanded residents' capacity to report problems and participate in real-time monitoring of smart city services.

The diffusion of mobile technology and mobile broadband is a key enabler for crowdsourced monitoring of smart city services. At the global level, 5.5 billion people (67%) were reported using the internet in 2024, with mobile-broadband coverage exceeding 95% of the population in every region (ITU, 2024). Sub-Saharan Africa combines rapid mobile-phone penetration with persistent affordability, literacy and device-quality gaps (GSMA, 2024), creating both opportunity and risk for crowdsourcing-based monitoring. The figures indicate a plausible infrastructural basis for inclusive, low-friction citizen reporting via Short Message Service (SMS) and Interactive Voice Response (IVR). However, this potential depends on explicitly addressing digital divides related to affordability, device capability, gender and digital literacy (GSMA, 2024; Rugeiyamu et al., 2025). Crowdsourcing-based monitoring links long-standing debates about citizen participation and power in governance. Arnstein (1969) "ladder of citizen participation" reminds that participation mechanisms may remain at tokenistic or manipulative rungs unless information flows translate into decisions and visible service improvement. Empirical and theoretical work updates this insight for the smart city era, arguing that digital participation is meaningful only when three conditions are met: (i) multiple, low-barrier channels; (ii) organisational workflows that convert citizen input into administrative

action; and (iii) feedback loops that close the communicative cycle between residents and authorities (Sjoberg et al., 2017). Without these conditions, crowdsourcing can generate large volumes of reports without commensurate service gains, a pattern documented in flagship field experiments (Buntaine et al., 2021; Grossman et al., 2018).

The review adopts the position that crowdsourcing should be analysed as a socio-technical accountability system rather than a data-collection device. In a smart city governance context, a socio-technical accountability system goes beyond technology performance. It also considers who designs the technology and who controls the data. It examines who is included or excluded. It also looks at how decisions are made and who can challenge or correct outcomes. The system comprises four linked components: citizen contribution, validation and integration, government response and feedback to citizens (Charalabidis et al., 2014; Sjoberg et al., 2017). Breakdowns in any one component erode the whole. For example, Buntaine et al. (2021) demonstrate that more than 33,000 SMS reports on solid-waste services in Kampala, Uganda over nine months yielded no measurable reduction in informal waste accumulation, partly because reports were inconsistent, not actionable and misaligned with managerial routines. Similarly, Grossman et al. (2018) find limited and domain specific service effects from the U-Bridge ICT reporting platform in Arua District, Uganda, emphasizing that actionability and institutional responsiveness matter more than sheer participation volume. In addition, eequity is an equally pressing concern. Studies of 311/Open311 ecosystems show socio-spatial biases: low-income and minority neighbourhoods often under-report certain issues despite objectively higher levels of need, and resolution times can vary unequally across race, income, and gender lines (Clark et al., 2013; Kontokosta & Hong, 2021; Schiff, 2025; O'Brien, 2016). These findings are significant because an increasing number of cities use citizen reported data to drive data-driven resource allocation (Kontokosta & Hong, 2021). The equity challenge is not confined to high-income contexts. In Tanzania, Rugeiyamu et al. (2025) find that local government authorities use of social media is predominantly informational rather than participatory, limiting its contribution to budgeting and service monitoring cycles.

This review is particularly relevant to low-and middle-income country contexts for three reasons: first, urban digital transformation strategies increasingly frame ICTs as an enabler for citizen service monitoring, with explicit commitments to expanding digital public service delivery (URT, 2016, 2022). Second, high mobile penetration and established SMS ecosystems provide a plausible infrastructure for mass participation, although digital divides persist (GSMA, 2024). Third, practical initiatives such as community mapping in Dar es Salaam, flood-resilience dashboards and MajiVoice complaint systems in East Africa, illustrate how crowdsourced service-quality data can expand monitoring beyond conventional administrative boundaries (Lopes et al., 2017; Msilanga et al., 2018). Literature indicates rapid growth of crowdsourcing applications in smart city contexts, but also stress the limited consolidation of evidence on governance (Simonofski et al., 2021; Zhang et al., 2025). The present review responds to this gap by synthesizing evidence through crowdsourcing community monitoring of smart city services, with focus on the channel design, participation dynamics, data actionability, equity and bias, and institutional response in low-and middle-income country settings. The review makes three contributions: first, it synthesizes evidence from both the Global North and the Global South, with particular attention to low-and middle-income countries; second, it develops an

actionable framework of five mechanisms that shape the effectiveness of crowdsourcing, and third, equity-focused critique of reporting bias in city governance.

CROWDSOURCING AND COMMUNITY MONITORING: APPROACHES, METHODS AND ACTORS

Crowdsourcing and community monitoring approaches emphasize collective participation, local knowledge and shared responsibility in observing change. The methods also support the systematic collection, verification and interpretation of information across diverse contexts. The actors include communities, institutions, researchers, practitioners and technology intermediaries, whose roles shape data quality, legitimacy and use. In Table 1 the descriptions distinguish the most locally based approach, autonomous monitoring, from less locally embedded forms of monitoring. Autonomous locally-based monitoring involves local people in the whole process of the design, data collection and decision making. Externally driven monitoring is the least locally based approach. In this approach, local stakeholders have no influence over the design or use of the results.

Table 1: Approaches to community-based monitoring

Approach	Description
Autonomous local monitoring	▪ Locally-based monitoring undertaken autonomously by local people ▪ Local stakeholders are involved in the whole process -from design stage to use of data for management decision ▪ No direct involvement of external agencies, except advocate the continued relevance of the programs ▪ There is very little professional documentation of the results ▪ The most locally-based monitoring programs
Collaborative monitoring with local data interpretation	▪ Locally-based monitoring in data collection, analysis and interpretation, but external scientist may offer advice and training ▪ Collected data by local stakeholders remain in the area being monitored ▪ Create locally-based ownership of the monitoring programs ▪ Local-based monitoring are externally supported ▪ Management decisions and other rights have been devolved to the local community
Collaborative monitoring with external data interpretation	▪ Involves local community in data collection and degree of management-oriented decision-making ▪ Data analysis and interpretation are undertaken by external expertise (researchers, scientists) ▪ Community serves as volunteers and may be paid their time ▪ Data analysis is not undertaken by local stakeholders, so may not incorporate local perspectives ▪ There is no devolved management rights and responsibilities, but there is sharing of management cost and benefits
Externally driven and professionally implemented monitoring	▪ These approaches do not involve local communities ▪ The design, analysis and decisions are undertaken by professionals funded by external agencies ▪ Very expensive to sustain over time and reliant on skills that are not endemic
Externally driven monitoring with local data collectors	▪ Local stakeholders are involving only in data collection ▪ Local data collectors have no influence over design, analysis and interpretation of the monitoring results ▪ Local stakeholders can be paid to collect data ▪ Decisions are made by remote government agencies or non-governmental organisations ▪ Least locally-based monitoring programs

Source: Danielsen et al., 2009; Kouril et al., 2016

The principles of crowdsourcing for problem-solving offer opportunities for different methods that can be used to engage the crowd through digital tools in service monitoring. A crowd initiator may engage different groups of participants depending on the purpose and nature of their engagement. The capacity to process generated information and digitally enable crowd participation determines the type of

crowdsourcing. Therefore, the literature has identified different methods of crowdsourcing in smart city service monitoring. These methods include: collaborative, co-created and contributory (World Bank, 2016), open, closed and passive (Charalabidis et al., 2014; Shayo, 2022). Table 2 presents the summary of each type of crowdsourcing.

Table 2: Crowdsourcing community monitoring methods

Method	Description
Collaborative crowdsourcing	▪ Designed by crowd-initiator and communities ▪ Contribute in data collection, sharing and decision making ▪ Motivation is necessary for the community to participate ▪ Community members can assist with mode of participation ▪ Promote a sense of ownership in data collection and communication
Open crowdsourcing	▪ Undefined group of active community members invited to participate in data collection and sharing ▪ Generated data requires process of verification ▪ Participants are voluntarily invited to generate data ▪ Different types of media are used to invite connected crowd
Contributory crowdsourcing	▪ Crowd-initiator driven community participation in monitoring ▪ Crowd-initiator designs methods of participation, channels for communication and type of data to be collected and shared ▪ Community members generate information predetermined by crowd-initiator ▪ Community members are data collectors ▪ Generated data are analysed and shared with relevant authorities and community for feedback ▪ Crowd monitors have no room to decide any of the steps in data production ▪ Data are collected over wide geographical area
Co-created crowdsourcing	▪ Community members come up with a concern ▪ Community members encourage the crowdsourcer to take action in addressing the issue ▪ Community members exert significant control and ownership ▪ Data are shared by the crowdsourcer and community members as monitors and reporters of the social events
Closed crowdsourcing	▪ Purposive crowdsourcing to create a trusted team for data collection ▪ Involves recruitment and training of community members as data collectors ▪ Engage few recruited participants, often called “trusted” social monitors ▪ Crowd participants are recruited based on the recommendation by members within their established members networks ▪ The roles of participants are clearly defined ▪ Participant-generated data are not subjected to verification process
Passive crowdsourcing	▪ Social networkers ▪ Social media platforms are used to share community issues ▪ Data are collected through data mining to understand issues, user opinions and proposals ▪ Require digital volunteers to process data ▪ Passive participants are the majority, who are unengaged group in the formal process of monitoring.

Source: Charalabidis et al., 2014; Hellström, 2015; World Bank, 2016; Shayo, 2022.

In collaborative crowdsourcing, communities should be enabled to actively participate in the crowdsourcing processes in order to generate and interpret the data. Crowdsourced monitoring organisations need to understand the motivators that encourage community members to be active participants in the monitoring process. Through contributory crowdsourcing communities are invited to participate in a space already formalized to play the role of data collection. Community members are encouraged to participate by using created ICT channels in two ways: through open participation, and closed participatory approach. In open crowdsourcing, crowd initiators guide the community members about what, where and how to report. Crowdsourced organisations tend to use available and accessible digital tools to mobilise the public to participate in sharing their observation. In closed crowdsourcing, crowdsourcer work with recruited and trained monitors for the purpose of generating trusted service monitoring data.

The roles of participants should be clearly specified to generate unbiased social monitoring information using digital devices. Co-created crowdsourcing enables community members and crowdsourcer to generate and share information as monitors and reporters of the social events. Passive crowdsourcing involves social media platform users, who used to share social information without any invitation to participate. Social network users may develop hashtags and keywords as alert that some social issues require attention by the government authorities.

The shift to crowdsourced community-based monitoring changes how different actors, including the private sector, public sector, communities, and third-sector organisations, can contribute to service monitoring. Initiatives for crowdsourced participation are championed by CBM organisations to gather information and co-produce standards of service delivery in the cities. Digital initiatives for community crowdsourcing are designed by civic organisations to collectively promote monitoring, co-production and co-dissemination of community-generated voices regarding social services. Technology creates opportunities for monitoring and disseminating information about social services (Shiyo et al., 2018). Various actors are interested in exploiting the capabilities of crowdsourcing community-based monitoring methods empowered by ICTs. Crowdsourcing as a collective intelligence comprises organisation that benefits from the crowd work, the crowd itself and a platform that links all together. Table 3 presents actors, role and data relationship for community-based monitoring.

Table 3: Actors in crowdsourcing community monitoring

Key actor	Role	Data relationship
Public sectors	Data collector Data user Data provider Service provider	▪ Collect and disseminate data to communities ▪ Use data collected for planning, management and emergency response ▪ Uses mobile applications and other innovations as a communication tool with the communities
Mobile network operators	Data collection enabler	▪ Provide and manage the mobile networks, and provide the hosting platform
Application developers	Data collection enabler	▪ Support the development and implementation of mobile and smartphones applications, as well as enables transactions
Non-governmental organisations	Data collector Data user Data provider	▪ Mobile application supports an NGO's mission of advocacy, raising awareness and monitoring
Private sector	Data collector Data user Data provider Service provider	▪ Commercial applications primarily involve supplying consumers with data or analysis for payment or to encourage customer loyalty or promotional service ▪ Commercial applications are also developed to promote transactions between parties
Researchers	Data collector Data user	▪ Researchers collect data to inform service providers ▪ Incorporates data into research and discovery ▪ Use data to recommend evidence-based policy for quality services
Media	Data user	▪ Report current conditions or trends to the public in near-real time ▪ Use data to create awareness of the standards of services to the communities and service providers ▪ Use data to influence openness and accountability
Citizens / communities	Data collector Data user	▪ Citizens collect data to inform government agencies ▪ Amount citizens access disseminated data is a function of relevance, perceived benefit, education, and financial level ▪ Government agencies use information to make decisions concerning communities

Source: Adapted from World Bank (2016, pp. 18-19)

It may not be possible for every affected community to contribute in service monitoring. Considerations of actors, role, type of digital tools, data relationship, network coverage and information type are important issues to be considered in crowdsourcing community monitoring. In crowdsourced community-based monitoring, participation is open to a potentially unlimited number of community members, each of whom contributes small, discrete pieces of information, often voluntarily and without monetary compensation (Fung et al., 2013, p.42).

CROWD MONITORING OF SMART CITY SERVICES

Theoretical framing

Crowdsourcing community monitoring of smart city services lies at the intersection of urban governance, digital transformation and citizen participation. It is aligned with the Sustainable Development Goals (SDG 11, inclusive, safe, resilient and sustainable cities and communities, and SDG 9, resilient infrastructure, inclusive industrialisation and innovation (United Nations, 2015). Grandvoinnet et al. (2015, p. 295) define community monitoring as "a system of measuring, recording, collecting and analysing information and communicating and acting on that information to improve performance". The purpose is to "hold government institutions accountable, provide ongoing feedback, share control over monitoring and evaluation, engage in identifying or taking corrective actions, and facilitate dialogue between citizens and project authorities" (Grandvoinnet et al. (2015, p. 295). While Whitelaw et al. (2003: 410) identify three drivers for initiating community monitoring: (i) reduced state capacity following fiscal consolidation; (ii) the inadequacy of authoritative monitoring for addressing complex sustainability issues; and (iii) a recognised need to involve stakeholders in planning and management. OECD (2023) and UN-Habitat (2024) have restated these drivers within a people-centred digital governance frame, emphasizing that citizen-generated data must be governed for trust, privacy, inclusion and accountability.

Crowdsourcing channels

Digital crowdsourcing channels for monitoring smart city services offer four areas of innovation. First, crowdsourcing channels are used to share information about smart city services. Second, digital channels are used to monitor and map urban problems, alerting inhabitants and local government authorities to service failures. Third, digital channels provide avenues for participation by crowdsourcing new ideas to improve urban goods and services. Fourth, digital channels connect people by mobilizing networks for 'care and share' initiatives, for example around waste collection and cleanliness (Kersting, 2020). In crowdsourcing for community monitoring, five channels dominate contemporary practice. First, structured issue reporting systems, such as 311/Open311 in North America, FixMyStreet in the United Kingdom, SeeClickFix across several Anglophone contexts, and municipal complaint applications, accept service requests through hotlines, web portals and mobile apps, typically with geolocation and photo evidence (Offenhuber, 2015; Sjoberg et al., 2017; Stowers, 2022). Second, SMS/IVR reporting systems extend access to feature phone users, a critical design choice in low- and middle-income country settings (Grossman et al., 2017, 2018; Lopes et al., 2017). Third, VGI and collaborative mapping platforms like OpenStreetMap and Ushahidi, generate foundational geospatial data for resilience, infrastructure visibility and service planning (Msilanga et al., 2018; Young, 2014; Zhang et al., 2025). Fourth, participatory sensing deploys everyday sensors such as smartphone microphones and GPS traces, to generate data on noise, air quality, traffic or infrastructure quality. Fifth, passive

crowdsourcing learns from content that citizens already share on social media, without issuing explicit calls, an approach that expands informational reach but raises distinct privacy and representativeness concerns (Charalabidis et al., 2014; Shayo, 2022; Rugeiyamu et al., 2025).

The rapid penetration of mobile phones, the internet and related digital tools in Africa has enabled governments and civic organisations to harness collective intelligence in ways that were infeasible a decade ago (Robbins, 2018). Offline community participation, in which public agencies convene citizens in physical spaces for consultation, has been progressively extended through digital channels (Kersting, 2020), allowing participation at scale, but also exposing limits such as the digital divide, the disembedding of civic exchange from local social relations, and platform-design bias. Crowdsourcing now features prominently in government and civil society initiatives for service co-production, complaint management, participatory planning and social accountability (Brabham, 2013; Grossman et al., 2018; Liu, 2021; Simonofski et al., 2021).

Crowdsourcing outcomes and conditions for impact

Empirical evidence on outcomes is mixed and context-dependent. Liu (2021) demonstrates that community engagement via crowdsourcing can improve efficiency and perceived service quality in monitoring public services. Sjoberg et al. (2017) show that bureaucratic responsiveness on FixMyStreet is associated with higher repeat reporting probabilities, suggesting a virtuous cycle when administrative responses are timely and visible. Abu-Tayeh et al. (2018) find both self-concern and other orientation motives predict citizen-reporting engagement in Zurich, indicating crowdsourcing draws on a broader motivational base than pure self-interest. Zhang et al. (2025) reported VGI tools can support productive issue reporting even as perceptions of usefulness diverge between citizens and officials. Methodological robust in low- and middle-income countries evaluations find limited-service impact despite strong participation. Buntaine et al. (2021) observed citizen SMS reporting did not reduce informal waste accumulation in Kampala, attributing the failure to report inconsistency and misfit with managerial processes. Grossman et al. (2018) similarly find that the U-Bridge platform produced short-term, domain-specific improvements, for example, in some education services, but no consistent effects in health or water, with institutional response quality emerging as the decisive mediator. These results reinforce three cross-cutting conditions for crowdsourcing of community-based monitoring value at scale: channel inclusiveness, data actionability and institutional responsiveness (Charalabidis et al., 2014; Kontokosta & Hong, 2021; Sjoberg et al., 2017).

Equity, bias and digital divides

The Kansas City 311 bias study triangulates complaint data with objective street condition assessments and resident surveys, showing that low-income and minority neighbourhoods are less likely to report certain problems despite greater need (Kontokosta & Hong, 2021). Schiff (2025) reports uneven acknowledgement and resolution on SeeClickFix across neighbourhoods in the United States. Clark et al. (2013) report disparities along race, education and income in Boston co-production pipeline; and FixMyStreet data from Brussels show unequal participation across ethnically diverse districts (Pak et al., 2017). These findings imply that complaint driven optimisation may reinforce inequality unless corrected by bias aware triangulation with administrative or sensor data and equity-centred governance (OECD, 2023).

Equity concerns extend to low- and middle-income countries contexts but take different

forms. In Tanzania, Rugeiyamu et al. (2025) find that local government authorities use social media for informational communication rather than participatory budgeting or development planning, a gap between digital presence and meaningful participation in decision cycles. In Indonesia, Hidayat et al., (2021) identifies institutional and implementation factors (not just digital access) as the primary determinants of reporting system effectiveness in Makassar. India SafetiPin platform (Trang, 2022) illustrates how crowdsourced safety audits can reveal gendered exclusion that may not appear in conventional city data. Similarly, Young (2014) shows how Egypt's HarassMap uses crowdsourced incident data to support advocacy and community mobilisation. These cases suggest that crowdsourcing equity performance depends less on platform design alone than on the articulation between platforms, institutions and wider civic ecosystems.

Institutionalisation of crowdsourcing

Crowdsourcing monitoring of smart city services remains relatively new in Africa, although mobile innovations have diffused and leapfrogged high-income pathways (GSMA, 2024). Estevez et al. (2016) identify structural factors that widen the gap between smart city rhetoric and local realities in developing countries, including (i) weak research capacity, (ii) policy work predominantly undertaken in high-income settings and (iii) dependence on externally derived policy frameworks that may not fit local contexts. Recent literature emphasizes the need to invest in the Internet of People alongside the Internet of Things**.** This means prioritizing social processes, human capacity development, and residents' roles as co-creators rather than end-users of technology (Mayangsari & Novani, 2015). Community-based monitoring has been adopted across sectors to enhance efficiency and effectiveness by improving service quality (Liu, 2021). ICTs offer not only convenient access to data, but also opportunities to connect citizens with government and non-state actors (Shiyo et al., 2018). Participation through ICTs encompasses, e-information, empowering access, e-consultation, and e-empowerment, co-designing and co-producing services (Shiyo et al., 2018).

METHODS AND MATERIALS

Study design

The methods are reported in accordance with the PRISMA 2020 statement for systematic reviews (Page et al., 2021). PRISMA requirement for anticipation of non-retrieval (inaccessible full texts) is upheld. All instances of non-retrieval are systematically documented, and the corresponding reasons for non-retrieval and exclusion are reported in Table 4. Inclusion and exclusion criteria were specified using Population, Interest and Context (PICo) framework, appropriate for mixed evidence (Hong et al., 2018). Here, *Population* defines urban residents or citizens and city authorities; *Interest* entails crowdsourcing, citizen reporting or citizen-generated data for monitoring and feedback; and *Context* includes smart city services and municipal service delivery. Table 4 summarizes inclusion and exclusion criteria.

Table 4: Inclusion and exclusion criteria

Criteria	Included	Excluded	Rationale
Language	English	Non-English	Consistent with the available bibliographic resources, limitation acknowledged.
Publication type	Peer-reviewed journal, conference papers, high-quality institutional reports like OECD, ITU, UN system and World Bank evaluating city service monitoring mechanisms	Opinion pieces without method and marketing materials	Ensures traceable evidence and governance relevance.

Time window	2006-2026 (emphasis on the most recent 10 years)	Pre-2006, unless foundational	The term crowdsourcing is widely dated to Howe (2006); earlier participation theory used when foundational.
Phenomenon	Citizen-generated reporting, mapping or sensing used for monitoring, feedback or accountability in urban services like Open311, FixMyStreet, SeeClickFix, SMS reporting and volunteered geographic information.	Pure Internet of Things sensing without citizen input, and general smart city conceptual work without monitoring linkage	Keeps the review focused on community monitoring, service monitoring and reporting.
Outcome relevance	Evidence on implementation, participation, data quality, responsiveness, equity, service outcomes or governance implications	No mention of how crowdsourced data is used or connected to service processes	Crowdsourcing community monitoring requires a link to use or action.
Setting	Urban or municipal service context, or city services systems	Exclusively rural, unless framed as a service monitoring platform transferable to city services	Maintains smart city services focus, while allowing selective digital technologies transferability.

Search strategy

Searches were conducted between 22-30 December 2025 in Scopus, Web of Science Core Collection, IEEE Xplore and ACM Digital Library. Targeted searches of institutional repositories were undertaken for (i) smart-city governance standards, and (ii) crowdsourcing-for services frameworks, including OECD iLibrary, ITU publications, UNDESA, UN-Habitat and World Bank Open Knowledge. Search keywords were constructed around three concept blocks combined with AND: (i) smart city / city services; (ii) crowdsourcing / citizen reporting / community monitoring / volunteered geographic information / participatory sensing; and (iii) monitoring / service delivery / accountability / feedback / responsiveness. The search keywords are: “smart city” OR “smart cities” OR “smart sustainable city” OR “digital city” OR “municipal service” OR “urban service” OR “city service” AND “crowdsourcing” OR “citizen report” OR “citizen reporting” OR “issue reporting” OR “citizen-generated data” AND “monitoring” OR “monitor” OR “community monitoring” OR “crowd-monitoring” OR “service delivery” OR “city service monitoring” OR “accountability” OR “responsiveness” OR “feedback loop” OR “volunteered geographic information”.

Study selection and quality

The study selection considers titles and abstracts using the eligibility criteria. Full texts were then assessed for eligibility with reasons for exclusion logged in line with PRISMA 2020. The study selection process followed a structured screening and eligibility procedure. A total of 484 records were identified from databases and additional sources. After removing 141 duplicates, 343 records were screened based on titles and abstracts. Of these, 271 records were excluded, and 72 reports were sought for full-text retrieval, with 14 not accessible. Accordingly, 58 full text articles were assessed for eligibility. Studies were excluded for not focusing on service monitoring (n= 15), lacking a citizen crowdsourcing component (n= 9), being outside an urban context or having low transferability (n= 6) or providing insufficient methodological detail (n= 4). In this, 24 studies met the inclusion criteria and were included in the qualitative synthesis. An overview of the study identification, screening, eligibility and inclusion process is presented in Figure 1.

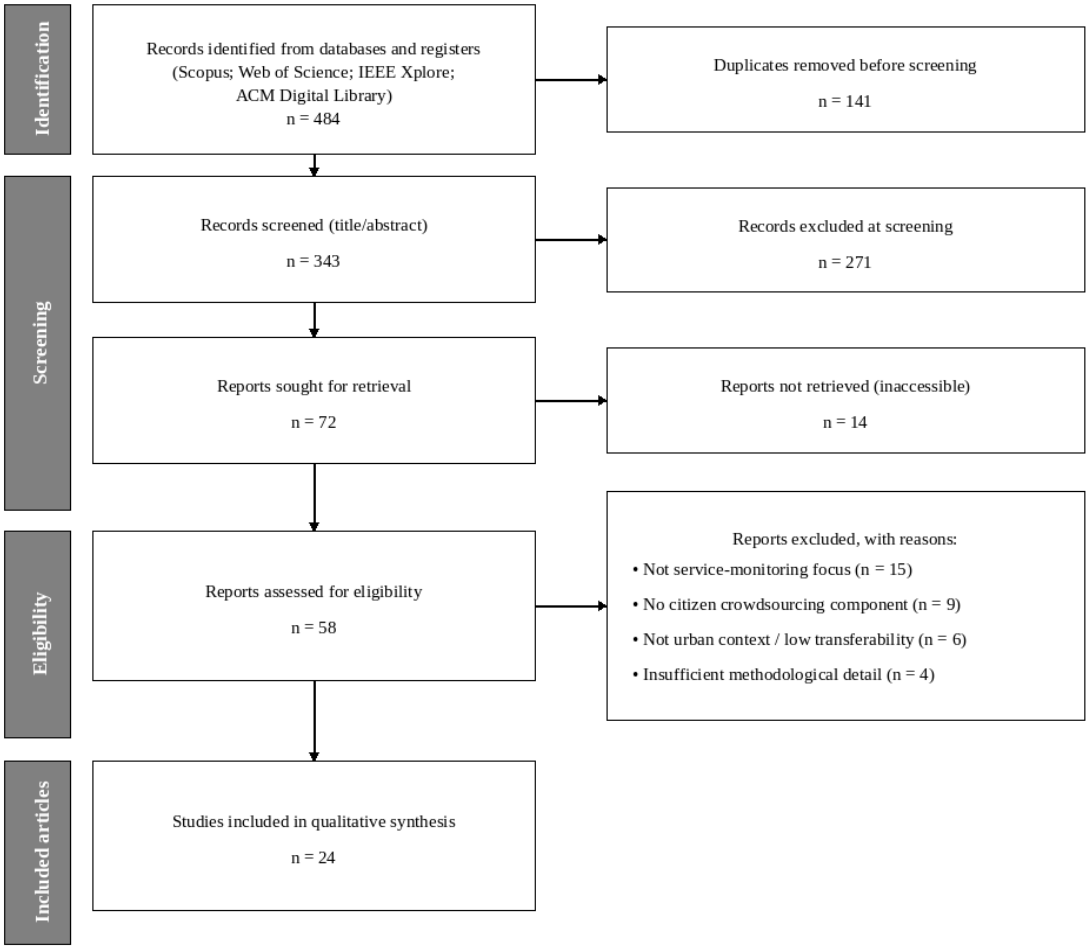

Figure 1: Study identification and PRISMA selection flowchart

Given the heterogeneity of study designs, the Mixed Methods Appraisal Tool (MMAT) was the primary methodological quality instrument (Hong et al., 2018). MMAT is designed for systematic mixed studies reviews and enables comparable judgement across qualitative and quantitative methods studies. The synthesis followed a thematic approach supported by descriptive mapping of the study counts by service domain, channel and region. Analytical themes were developed through coding of the extracted data and cross-case comparison. The synthesis is structured around mechanisms that determine whether crowdsourcing becomes a functional community-based monitoring system: (i) crowdsourcing types and channel types and inclusion, (ii) motivation and participation dynamics, (iii) data quality and actionability, (iv) equity and bias, and (v) institutional response and governance. Counts reflect the compiled search log and screening decisions; non-retrieval include inaccessible web interfaces, reported explicitly as recommended by PRISMA and flow constructed in accordance with Page et al. (2021).

Data extraction

A structured data-extraction form (Table 5) was piloted and refined to ensure consistency across designs and disciplines. Extracted variables covered bibliographic metadata, city/country/income context, service domain, crowdsourcing channel, participation type (open/closed/co-created/passive), verification methods, integration into administrative workflows, outcome measures and equity/privacy considerations.

Table 5: Data extraction form

Domain	Field	Operational definition
Bibliographic	Authors, year, doi	Standard citation metadata.
Context	Country, city, income context, urban typology	Study setting and transferability.
Service focus	Service domain	Municipal maintenance (potholes, lighting), waste, water utilities, public safety, mobility, education, health, environment.
Crowdsourcing mechanism	Channel	App, web portal, SMS, call centre, social media mining, volunteered geographic information mapping, participatory sensing.
Crowdsourcing type	Participation mode	Active reporting vs passive crowdsourcing, contributory vs collaborative vs co-created.
Data quality	Verification	Moderation, duplication, ground-truth checks, photo evidence, geotagging, validation.
Integration	Workflow linkage	How reports enter city systems, prioritisation, response times, feedback to citizens.
Outcomes	Participation, responsiveness, service change	Reports submitted, repeat participation, acknowledgement, measurable service indicators.
Equity and ethics	Inclusion, bias, privacy	Under-reporting biases, digital divide, anonymity, data protection, governance arrangements.

RESULTS

Study characteristics

Included studies cluster around four categories: (i) municipal request and issue reporting ecosystems, (ii) citizen reporting and accountability, (iii) volunteered geographic information-based collaborative mapping for resilience and infrastructure visibility, and (iv) passive crowdsourcing designs leveraging social media discourse for policy insight. Table 6 summarises study characteristics.

Table 6: Characteristics of included studies (n=24)

ID	Authors	Study setting	Service / domain	Channel	Main contribution for crowdsourcing monitoring of city services
S01	Brabham (2009)	General (conceptual)	Planning participation	Open web crowdsourcing	Frames crowdsourcing as a participation model relevant to public sector problem solving.
S02	Clark et al. (2013)	Boston, USA	311 service requests	Multi-channel reporting	Documents distributional biases in technology-enabled co-production.
S03	Offenhuber (2015)	Boston, USA	Open311 feedback systems	Web/mobile issue reporting	Shows how design assumptions shape citizen-city interaction.
S04	Charalabidis et al. (2014)	Austria/Greece /UK	Policy insight	Passive crowdsourcing	Proposes process and ICT architecture for passive crowdsourcing via social media.
S05	O'Brien (2016)	Boston, USA	311 reporting	Hotline/digital reports	Treats 311 as "small data" revealing neighbourhood social processes.
S06	Grossman et al. (2017)	Uganda	Service deficiency reporting	SMS reporting	Messaging design can increase citizen reporting participation.
S07	Sjoberg et al. (2017)	United Kingdom	Local issue reporting	FixMyStreet	Links bureaucratic responsiveness to citizen participation.
S08	Wang et al. (2017)	US cities	311 service requests	311 open data	Structure of 311 requests functions as a signature of urban location.
S09	Lopes et al. (2017)	Kenya	Water utility complaints	Multi-channel feedback	Evaluates complaint management and organisational responsiveness (MajiVoice).
S10	Msilanga et al. (2018)	Tanzania	Flood resilience and infrastructure mapping	OpenStreetMap collaborative mapping	Large-scale community mapping as monitoring for resilience planning.
S11	Abu-Tayeh et al. (2018)	Zurich, Switzerland	Infrastructure issue reporting	Mobile reporting app	Identifies motivational drivers (self-concern, other-orientation).
S12	Shiyo et al. (2018)	Tanzania	Service governance	Mobile participation	Maps citizen m-participation initiatives and gaps.

S13	Buntaine et al. (2021)	Kampala, Uganda	Solid waste services	SMS messaging platform	Participation at large-scale but limited-service improvement when reports are not actionable.
S14	Grossman et al. (2018)	Arua District, Uganda	Education/health/ water	ICT reporting platform	Limited, domain-specific service effects; actionability decisive.
S15	Hidayat et al. (2021)	Makassar, Indonesia	Citizen reporting system	Smart RT / RW application, Call Centre 112, Home care and Qlue	Institutional and implementation factors shape reporting effectiveness.
S16	Kontokosta & Hong (2021)	Kansas City, USA	Street conditions & "nuisance" services	311 complaints	Quantifies socio-spatial bias; warns against inequitable "data-driven" governance.
S17	Stowers (2022)	29 US cities	311 systems	311 request systems	Comparative typology of service categories and system operations.
S18	Schiff (2025)	US Multi-cities	Maintenance issues	SeeClickFix	Differential acknowledgement/resolution patterns by neighbourhood.
S19	Zhang et al. (2025)	Kitchener, Canada	Public service co-production	Volunteered Geographic Information (VGI) tools (geosocial media)	Divergent perceptions of VGI usefulness between citizens and officials.
S20	Rugeiyamu et al. (2025)	Tanzania (LGAs)	Engagement & service delivery communication	Social media	LGAs use social media informationally; limited participatory budgeting linkage.
S21	Trang (2022)	India	Women's safety auditing	Mobile crowdsourcing	Citizen-generated safety data as a city-relevant monitoring layer.
S22	Young (2014)	Egypt	urban safety	Crowdmapping (HarassMap)	Crowdsourced incident data supports advocacy and community mobilisation.
S23	World Bank (2016)	Multi-setting	Water quality monitoring	Mobile testing (framework)	Implementation considerations for crowdsourcing in service-quality monitoring.
S24	OECD (2023)	Multi-setting	Smart city data governance	Governance framework	Pillars and safeguards for citizen data use and trust in smart cities.

Quality appraisal summary

The review spans conceptual contributions, observational analyses, field experiments and programme evaluations. MMAT 2018 supports comparable judgements across qualitative, quantitative and mixed-methods designs. For the field experiments that directly tested service outcomes of citizen reporting (Buntaine et al., 2021) in Kampala solid waste; Grossman et al., 2018 in Arua multi-sector reporting). Studies highlight implementation realities such as actionability and institutional constraints, factors that classical bias tools may not fully capture but that are central to governance interventions. Table 7 summarizes typical strengths and limitations by study family.

Table 7: Quality appraisal summary by study family

Study family	Typical design	Appraisal tool	Recurrent strengths	Recurrent limitations / bias risks
311/Open311 and issue-reporting analytics	Observational spatial analytics	MMAT (quantitative non-randomised)	Large administrative datasets, spatial validation, clear operational measures (requests, resolution).	Reporting bias (who reports), inequitable data generation, complaints.
FixMyStreet-type participation studies	Observational behavioural analysis	MMAT	High ecological validity, links responsiveness to behaviour.	Platform users self-select, outcomes often participation rather than service quality, limited causal inference.
SMS citizen-reporting experiments	Randomised/field experiments	MMAT	Stronger causal designs, direct service outcomes attempted, implementation learning.	Implementation bias, variable uptake, inconsistent data, outcomes depend on bureaucratic capacity.
VGI / collaborative mapping for resilience	Case studies programme documentation	MMAT / qualitative appraisal	Demonstrates scalable community engagement and infrastructural visibility gains.	Attribution to service outcomes indirect, may privilege mapped areas/participants.

Passive crowdsourcing (social media)	Design science / qualitative	MMAT (qualitative)	Extends participation beyond explicit calls, surfaces issues at scale.	Privacy/ethics, representativeness, platform governance, risk of amplifying vocal minorities.

Thematic synthesis

The synthesis is organised around five mechanisms that determine whether crowdsourcing becomes a functional community-based monitoring system for smart city services, namely: channel design and crowdsourcing types, participation dynamics, data quality and actionability, equity and bias, institutional response and governance.

Theme 1: Channels and crowdsourcing types

A consistent pattern is the use of issue-reporting systems as the dominant service monitoring instance of crowdsourcing. 311 systems through hotlines, web tools and mobile interfaces, operate as structured service request pipelines that can be analysed both for operational performance and as signals of urban context (Offenhuber, 2015; Stowers, 2022; Wang et al., 2017). Crowdsourcing platforms vary in openness, some are open reporting (anyone can submit), others use bounded crowds (recruited reporters), and some are collaborative production approaches (VGI mapping in OpenStreetMap ecosystems) (Msilanga et al., 2018; Zhang et al., 2025). Passive crowdsourcing is conceptually distinct, rather than soliciting reports, governments learn from the content citizens already produce on social media networking sites (Charalabidis et al., 2014).

Theme 2: Participation dynamics

The FixMyStreet literature demonstrates that responsiveness itself shapes future participation. Citizens who experience effective response are more likely to continue reporting, turning crowdsourcing into a potentially self-reinforcing learning loop (Sjoberg et al., 2017). Abu-Tayeh et al. (2018) show, in Zurich, that both self-concern and other-orientation motivations predict reporting engagement, using combined survey and platform log data. These findings support the position that citizen participation is not merely a function of technology access, but of perceived value and civic orientation (Simonofski et al., 2021). In low resource settings, experimental evidence indicates that messaging design and perceived efficacy can influence willingness to report via SMS (Grossman et al., 2017); however, participation gains do not guarantee service improvement (Buntaine et al., 2021; Grossman et al., 2018).

Theme 3: Data quality and actionability

A central finding is that crowdsourcing is effective when citizen reports are actionable and aligned with the information needs of service providers. In Kampala, citizen SMS reporting generated tens of thousands of reports over nine months, but did not reduce informal waste accumulation, as the literature attributes part of the failure to inconsistent information and misfit with existing decision-making processes (Buntaine et al., 2021). In Arua, the U-Bridge experiment found suggestive short-term improvements in some education services, but little evidence of health or water effects, despite high uptake and official enthusiasm; reports often lacked specificity and actionability, and weak responses discouraged sustained engagement (Grossman et al., 2018). These findings align with the broader volunteered geographic information quality literature, which shows that citizen-generated data can be timely and low-cost, but quality assurance is not inherent (Goodchild & Li, 2012). For crowdsourcing community-based monitoring in smart city services, quality must be interpreted to include categorisation accuracy (is the report a true service failure?), usefulness (does it enable prioritisation?), and jurisdictional clarity (is it within the remit and resources of the

receiving authority?). Overall, the empirical record establishes actionability as the hinge between participation and service outcomes.

Theme 4: Equity and bias in crowd-reported data

The Kansas City 311 bias study integrates complaint data with resident satisfaction surveys and objective street condition assessments, finding that low-income and minority neighbourhoods are less likely to report certain problems despite greater need (Kontokosta & Hong, 2021). Similar patterns are documented in the Boston 311 system (Clark et al., 2013; O'Brien, 2016), and in Brussels FixMyStreet usage (Pak et al., 2017). Schiff (2025) extends these findings by examining differential acknowledgement and resolution across US cities on SeeClickFix. Equity concerns are not confined to high-income contexts. For Tanzania, Rugeiyamu et al. (2025) suggest that local government social media use is primarily informational, rather than participatory, indicating a gap between digital presence and meaningful participation in decision cycles. UN-Habitat (2024) warns that generic digital blueprints and divides can leave vulnerable groups behind. OECD (2023) emphasises the need for bias aware, and human rights consistent data governance. Gender, disability and informal settlement dimensions remain comparatively understudied in service monitoring through crowdsourcing crowdsourcing, with exceptions (Trang, 2022) and HarassMap (Young, 2014).

Theme 5: Institutionalisation, governance and sustainability

Crowdsourcing systems sit within a broader ecosystem of digital governance. OECD (2023) emphasises the need to institutionalise cooperation, clarify responsibilities, improve data management practices, build capacity and place transparency and data protection at the centre of smart city programmes. People-centred smart city guidance (UN-Habitat, 2024) highlights similar concerns, digital inclusion, human rights, governance clarity and accountability, framing citizen participation as core rather than optional. In Tanzania, national strategies (URT, 2016, 2022) explicitly position ICT and e-government as mechanisms to improve service delivery, transparency and accountability, creating an enabling environment for crowdsourcing initiatives. Sustainability, however, requires governance arrangements, standards and capacity building rather than isolated pilots. Complementary evidence from community mapping in Dar es Salaam shows that large-scale collaborative mapping can be institutionalised through partnerships (Msilanga et al., 2018). These partnerships can involve community members, students and public authorities. They can generate detailed infrastructure data at scale. However, sustainability depends on regular data maintenance. It also requires attention to data quality. Crowdsourced monitoring organisations should also understand what motivates community members to participate actively in monitoring.

DISCUSSION

This review consolidates fragmented evidence to argue that crowdsourcing is best understood as a service accountability infrastructure, a socio-technical system linking citizen experience to administrative response, rather than as a stand-alone participation feature of smart cities. The evidence demonstrates that participation is feasible at scale, including through low-tech channels such as SMS, but service outcomes depend on the institutional machinery that converts citizen reports into decisions and actions (Grossman et al., 2018; Sjoberg et al., 2017). In Kampala and Arua, the bottleneck was not merely participation, it was the mismatch between citizen-generated content and what service providers could act on, given resource constraints and decision routines

(Grossman et al., 2018). Buntaine et al. (2021) observed that citizen-centric digital transformation requires organisational redesign rather than only new front-end interfaces. The review adds empirical specificity: actionable reports, triage capacity and response quality jointly determine whether crowdsourcing becomes a sustained monitoring tool or an occasional pilot. Crowdsourcing can also reshape citizen behaviour and expectations through feedback loops. FixMyStreet findings connect bureaucratic responsiveness to continued participation (Sjoberg et al., 2017), implying a dynamic system in which better responses stimulate more reporting, while poor responses depress engagement and potentially worsen informational blindness. This is consistent with participation theory that positions meaningful responsiveness as the difference between tokenistic and empowered participation (Arnstein, 1969). When governments use citizen-reported datasets for smart optimisation, they risk encoding reporting inequalities into resource decisions (Kontokosta & Hong, 2021).

Under-reporting in disadvantaged areas is not only a data quality problem. It also reflects wider inequalities in access, voice and institutional response. This requires triangulating citizen reports with administrative inspections, sensor data and survey evidence. It also calls for bias-aware governance (OECD, 2023; UN-Habitat, 2024). Equity in community-based crowdsourcing should therefore be assessed beyond participation rates. It should also consider resolution outcomes across neighbourhood, income, gender and disability status (Schiff, 2025; Trang, 2022). For Tanzania and other low- and middle-income country settings, the review identifies both opportunity and caution. The opportunity is that high-scale mobile connectivity and established SMS ecosystems can support low-friction crowdsourcing interfaces. SIM subscriptions and expanding mobile broadband coverage in Sub-Saharan Africa (GSMA, 2024; ITU, 2024) offer an infrastructural basis for crowd participation. The caution is that institutional capacity, staff skills, and governance structures must be adequate for sustained crowdsourcing. National strategies acknowledge persistent weaknesses such as limited awareness of standards and uneven technical expertise (URT, 2016, 2022), which could undermine sustainability. Rugeiyamu et al. (2025) observed that even where digital channels exist, they are often used in broadcast mode, stopping short of genuine participation in decision cycles. On the basis of the synthesised literature, an agenda emerges for crowdsourced monitoring of smart city services: (i) design for inclusion by providing SMS interface in local languages alongside applications, (ii) build verification capacity and develop operational rules for actionability and jurisdictional routing, (iii) institutionalise the feedback loop by designing response protocols that maintain citizen trust and sustained participation, (iv) adopt bias aware governance, and (v) align with data governance and human rights safeguards by incorporating privacy, transparency and accountability in line with OECD (2023) data-governance pillars and UN-Habitat (2024) people-centred smart city principles, and (vi) invest in the Internet of People, by linking technological deployment with digital literacy programmes to realise practical participation.

CONCLUSION AND LIMITATIONS

This systematic review concludes that crowdsourcing can support community-based monitoring of smart city services. However, it is effective only when designed and governed as an end-to-end accountability system. It should not be treated as a stand-alone participation app. Evidence from high-income 311/Open311 ecosystems and from African SMS-based

service reporting experiments converges on the same operational lesson. Citizen reporting generates information, but service improvement depends on actionability, workflow integration and response quality. Crowdsourced service monitoring is not always equitable. Reporting and resolution patterns can reflect socio-spatial inequalities. These biases may deepen inequality when citizen-reported data are treated as direct evidence of service need. Crowdsourced service monitoring is not automatically equitable. Reporting and resolution patterns can reflect socio-spatial inequalities. These biases may deepen inequality when citizen-reported data are treated as direct evidence of service need. Bias aware triangulation and equity-centred design are therefore essential to crowdsourcing-centred smart city implementation. In Tanzania, policy commitments to digital transformation and high-scale mobile ecosystems provide an enabling environment, however, sustainable deployment requires capacity building, standards and institutional arrangements that connect citizen input to decision-making and service response.

Therefore, future research priorities include: (i) comparative evaluations across services and cities, (ii) transparent measurement of service outcomes beyond complaint counts, (iii) experimental or quasi-experimental designs that examine institutional responsiveness as the mediating variable, and (iv) explicit assessment of inclusion, privacy and bias mitigation in crowdsourced monitoring systems. Progress on each of these fronts will help move crowdsourcing from an aspirational feature of smart city discourse to a credible, equitable and sustainable infrastructure for community-based monitoring. Several limitations should be acknowledged: English-only inclusion excludes relevant studies in Francophone and Lusophone Africa and Latin America. Access constraints (restricted web interfaces) affected retrieval of some full texts (n= 14), which is documented in the PRISMA diagram. Several included studies rely on administrative datasets (311 logs, platform reports) that capture participation and resolution, but may not capture underlying service quality. Risk remains that performance reflects reporting patterns rather than service change (Kontokosta & Hong, 2021). Although Tanzania relevant policy and context sources are included, peer-reviewed Tanzania-specific evaluations of crowdsourcing for city service monitoring remain limited, indicating a research gap consistent with Shiyo et al. (2018) m-participation mapping.

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