

# Smart Cities for Equitable Societies: Promoting Digital Equality, Trust, and Ethical Governance

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**Abstract**—In the field of smart urban systems, discussions often revolve around conventional challenges such as data privacy, integration of Internet of Things devices, and scalable infrastructure design. However, the focus on technological innovation often overlooks important concerns about digital equality, privacy, bias, and ethical governance. This paper aims to foster a shifting in the narrative towards these less discussed areas, arguing that the true measure of a smart city's success lies not only in its technological capabilities but also in its commitment to inclusivity, privacy, trust, and ethical integrity. This paper examines the inclusivity of smart services, emphasising the need for digital equality while also discussing privacy regulations and the role of trust in fostering citizen engagement. Additionally, it explores how decision-making can perpetuate inequalities and the importance of transparent governance. Such important discussions address ethical and social implications, which ultimately contribute to a more nuanced understanding of smart cities and advocates for policies and practices that prioritise social equity alongside technological innovations.

**Index Terms**—Algorithmic bias mitigation, Participatory Governance, Social inclusion, Ethical innovation.

## I. INTRODUCTION

Smart cities aim to enhance the quality of urban services, improve sustainability, and foster economic development. At its core, the smart city paradigm seeks to integrate digital technologies into urban infrastructure and services, making cities more intelligent, efficient, and responsive to the needs of their inhabitants [1]. However, technological integration into the urban environment presents complex challenges that extend beyond the technical domain into more societal perspectives.

Ensuring digital equality, privacy, trust, and unbiasedness within smart cities is crucial to making the benefits of urban services accessible and equitable. Digital equality, which refers to the fair distribution of digital resources and services, prevents the emergence of a digital divide that could worsen existing inequalities [2]. Privacy and trust are also crucial for citizen engagement. Concerns over data misuse and surveillance can erode public confidence and participation [3]. Additionally, the potential for algorithmic bias in decision-making systems highlights the need for transparent governance that upholds ethical standards and promotes social justice [4].

Although researchers usually acknowledge the importance of such concerns, even partially, Figure 1 shows that they

have been neglected in major scientific forums. Particularly, we took research works presented at the IEEE International Smart Cities Conference from 2015 to 2023 as a reference for analysis, which revealed the evolution of smart city research in almost a decade. Words related to technology (e.g., system, data, infrastructure) indicate their established centrality in smart city methodologies. However, equally critical terms such as ‘trust’, ‘fairness’ and ‘regulation’ are less imposing, indicating their peripheral treatment in scholarly discussions.



Fig. 1. Frequency of key terms associated with smart city research.

Therefore, this paper presents a critical review that explores important yet often overlooked aspects of smart cities. Specifically, it addresses challenges related to digital equality, privacy regulations, trust-building, bias mitigation, and ethical governance. Acknowledging the complexity of these conceptual elements, we perform a comprehensive discussion that prioritises inclusivity, equity, and ethical integrity, in addition to embracing technological innovation to ensure that

the development of smart cities aligns with the broader goals of sustainable and equitable urban development.

The remainder of this paper is structured as follows. Section II presents a critical literature review of the aforementioned aspects. Section III discusses challenges and future research works, followed by conclusions and references.

## II. LITERATURE REVIEW

### A. Inclusivity

In the context of smart cities, where access to services and participatory governance rely on connectivity, digital equality ensures equitable access to technologies and opportunities. This principle is crucial in ensuring that the advancements promoted by a smart city benefit all segments of society, thereby preventing the exacerbation of existing social divides [5]. Therefore, the benefits of urban technological innovations must be shared widely, promoting a more inclusive development trajectory.

Achieving digital equality within smart urban systems is a multifaceted challenge due to disparities in digital access. These disparities stem from socioeconomic, geographical, and educational inequalities, which can hinder the inclusivity of smart services. Vulnerable populations, such as the economically disadvantaged, elderly, and those in remote areas, often face barriers to accessing the internet and digital technologies, limiting their ability to benefit from smart city initiatives. Furthermore, rapid technological change can create a digital divide, leaving behind those without the skills or means to adapt [6]. These examples highlight the complexity of ensuring digital equality in the context of smart cities.

Strategies to enhance digital access and participation are crucial for addressing these challenges and promoting inclusive cities. Governments and urban planners should prioritise developing comprehensive digital inclusion strategies that include affordable internet access, public digital literacy programs, and the deployment of inclusive technologies designed with universal access in mind. Investing in public Wi-Fi networks and ensuring affordable broadband services can significantly enhance digital access in underserved communities [7]. Moreover, digital literacy programs, tailored to diverse age groups and proficiency levels, can equip citizens with the necessary skills to benefit from city services [6].

In addition to infrastructure and education, engaging communities in co-creating smart city initiatives can ensure that these efforts are grounded in urban residents' real needs and preferences. Participatory design processes, where citizens shape smart city projects from the outset, can lead to more equitable and effective solutions [8]. By promoting a culture of inclusiveness and collaboration, smart cities can transcend being mere technological showcases and become inclusive landscapes where digital equality is a reality.

### B. Privacy and Trust

Integrating technologies into the urban fabric introduces complex privacy and data governance dynamics. This seamless integration makes privacy regulations a critical aspect of smart

city initiatives [1]. These regulations serve a twofold purpose since they act as safeguards to protect individuals' data from being misused and provide an essential framework to guide responsible use of data. The impact of privacy regulations on smart cities is profound, as they directly influence the design, deployment and operation of smart services [9]. Regulations such as the European Union's General Data Protection Regulation (GDPR) set high standards for data privacy, mandating transparency, consent, and the right to data erasure. Such regulations force smart city planners to incorporate privacy-by-design principles, ensuring that technologies are efficient and compliant with privacy. While these regulations aim to protect citizens, they also pose challenges for smart city initiatives, requiring a delicate balance between using data to improve cities and respecting individual privacy rights [10].

Trust also plays a central role in discussions about the development of smart cities, as it is the cornerstone of citizen engagement and technology adoption. Trust is promoted when citizens believe that their data will be handled securely and used ethically and that the technologies deployed in their environment will add tangible value to their lives [11]. This trust is not automatic and must be earned through consistent, transparent practices and clear communication about the benefits and safeguards associated with smart city technologies [3]. Therefore, the role of trust extends beyond the initial adoption of technologies as it is an ongoing requirement for sustainable engagement and the successful evolution of smart city ecosystems. Without trust, even the most well-intentioned smart city initiatives risk facing public scepticism, resistance, and reduced participation.

Successful practices for building trust in smart cities can be observed in different global contexts. For example, the city of Barcelona has adopted a participatory approach to smart city development, involving citizens in decision-making processes and prioritising transparency in how data is collected, used, and shared [12]. This approach has fostered a sense of ownership among residents and increased trust in smart city projects. Similarly, Singapore's Smart Nation initiative has strongly emphasised data security and privacy, with robust legal frameworks and public education campaigns on data protection measures [11]. These efforts have been instrumental in building public trust and facilitating the smooth integration of smart technologies into everyday life.

### C. Algorithmic Bias

Algorithmic bias is a significant concern in smart city technologies, especially as they increasingly influence urban decision-making processes. At its core, such bias occurs when automated systems produce outputs that reflect biased assumptions or partial data, often perpetuating social inequalities [4]. In the context of smart cities, algorithms play a crucial role in various aspects, including traffic management, law enforcement, and resource allocation. However, it is fundamental to ensure that they are free from bias to avoid implications which exacerbate disparities and target or neglect certain communities based on flawed data or biased algorithmic

frameworks [13]. This challenge highlights the importance of examining the technologies from a social equity perspective to ensure they serve the diverse needs of populations in a fair and just manner.

Examples of bias in urban decision-making systems are manifold. Predictive policing tools, for example, have been criticised for reinforcing racial profiling because their algorithms often rely on historical crime data that may reflect systemic biases [14]. Similarly, algorithms used to distribute city services or infrastructure improvements can unintentionally prioritise certain areas over others based on biased criteria such as historical investment patterns, further disadvantaging marginalised communities [13]. These instances highlight how the algorithm's behaviour can replicate and amplify societal biases within the fabric of urban governance.

Mitigating bias and ensuring fair representation in smart city technologies requires a multifaceted approach. Firstly, it is crucial to incorporate diverse datasets that accurately reflect the heterogeneity of urban populations [15]. This diversity in data helps to counteract biases inherent in limited or skewed datasets, providing a more equitable foundation for algorithmic decisions. Secondly, the development and deployment of algorithms should involve multidisciplinary teams, including ethicists, sociologists, and community representatives, alongside technologists [?]. This interdisciplinary approach ensures that multiple perspectives inform the design and implementation of smart technologies, guarding against narrow or biases.

#### *D. Ethical and Social Implications*

Smart city initiatives also raise ethical dilemmas and social implications, particularly the pervasive surveillance and extensive data collection that underpin many smart city initiatives. While these technologies enhance urban efficiency and safety, they also pose privacy concerns and ethical questions regarding personal space and autonomy. The ethical considerations surrounding smart cities extend beyond privacy issues. Uneven distribution of access to these benefits can marginalise those less digitally literate or economically disadvantaged.

Pervasive monitoring and comprehensive data collection, often justified in the name of security and efficiency, can lead to a culture of monitoring that erodes the social fabric. Surveillance systems can limit free expression and movement, as citizens may alter their behaviour due to the knowledge of constant monitoring [16]. Additionally, the collection of personal data raises concerns about access, usage, and potential misuse. These practices challenge privacy principles and deepen the social implications of technological ubiquity.

Addressing ethical dilemmas and social implications in the smart city context requires the development of robust ethical frameworks and governance models [17]. However, these frameworks must prioritise transparency, accountability, and inclusivity to align with broader societal values and ethical standards. One proposed solution is the establishment of ethics committees or boards within municipal governance structures [18]. These committees should be dedicated to evaluating and guiding smart city projects through an ethical

lens. These bodies can provide oversight, review the ethical implications of proposed initiatives, and ensure that citizens' rights and privacy are protected.

Furthermore, governance models that prioritise participatory design and citizen engagement in the planning and implementation of smart technologies can mitigate many of the ethical concerns. Involving diverse community stakeholders in decision-making processes can help cities better understand the societal impacts of their initiatives and work towards equitable and just solutions [17]. This approach promotes ownership and trust among citizens, which is crucial for successfully integrating smart technologies into the urban environment. Proposals for ethical governance also suggest implementing privacy-by-design principles [19]. This method means embedding data protection and privacy protections at the onset of technology development.

### III. FUTURE RESEARCH AND PERSPECTIVES

Recent literature has produced important insights into digital equality, privacy and trust, algorithmic bias, and the broader ethical and social implications of urban technologies. It is clear that digital equality is fundamental to ensuring that the benefits of smart cities are accessible to all, thereby preventing the deepening of existing social divides. Privacy and trust are also crucial elements that support citizen engagement. Without strong privacy protections and trust-building measures, the adoption of smart technologies is at risk [11]. Similarly, algorithmic bias presents significant risks to social equity, emphasising the need for transparent and accountable mechanisms that evaluate and mitigate biases in urban systems [4]. In addition, deploying pervasive monitoring and data collection infrastructure raises ethical and social implications that require carefully evaluating their alignment with societal values and individual freedoms [16]. Addressing these issues is not only an ethical obligation but also a strategic imperative for the development of cities that are truly inclusive, reliable, and focused on the well-being of their residents.

Integrating ethical, inclusive, and privacy-centric considerations into smart city development poses significant practical challenges, ranging from technological limitations to policy barriers and governance complexities. One primary challenge is the rapid pace of technological advancements, which often outpace the development of comprehensive regulatory frameworks. This lack of synchronisation can lead to gaps in privacy and ethical oversight. Policy barriers can also present significant limitations, as legislation may fall behind or be ill-equipped to address the challenges of smart urban environments. Additionally, governance complexities arise from the need to coordinate multiple stakeholders with varying interests and priorities, limiting the participatory governance models and inclusive strategies. Overall, addressing these challenges presents unique opportunities for urban development: efforts to overcome technological and policy barriers can stimulate innovation, leading to the development of new solutions that are ethically sound and technologically advanced

Finally, based on the performed literature review, we identified a list of recommendations to be followed when constructing more equitable smart urban societies:

- **Prioritise Digital Inclusion:** Implement comprehensive digital inclusion strategies that ensure equitable access to technology and digital resources for all segments of society. This can include initiatives such as affordable internet access, public digital literacy programs, and the deployment of inclusive technologies designed with universal access in mind;
- **Enhance Privacy and Trust:** Integrate privacy-by-design principles into smart city initiatives, ensuring that technologies are developed and deployed with robust privacy protections and transparent data governance practices. Building trust among citizens through clear communication about data usage and security measures is crucial for fostering sustainable engagement with smart city projects;
- **Mitigate Algorithmic Bias:** Take proactive measures to identify and mitigate algorithmic bias in urban decision-making systems. This can involve incorporating diverse datasets, involving multidisciplinary teams in algorithm development, and implementing transparent and accountable governance models for algorithmic decision-making;
- **Address Ethical and Social Implications:** Establish robust frameworks and governance models to address the ethical and social implications of smart city technologies. This includes setting up ethics committees within municipal governance structures, promoting participatory design processes, and embedding privacy protections and data governance policies into technology development;
- **Evaluate Social Impact:** Develop methodologies for assessing the social impact of smart city technologies, incorporating interdisciplinary approaches that combine technology assessment with social science perspectives. This will help ensure that smart cities are grounded in the needs and concerns of diverse urban populations.

#### IV. CONCLUSION

This paper has briefly examined the critical yet often underexplored areas of smart cities of digital equality, privacy and trust, algorithmic bias, and ethical and social implications. Through this exploration, it becomes evident that the success of smart urban environments depends not solely on technological advancement but equally on addressing these pivotal concerns. As cities continue to develop, it is paramount that these environments do not simply become technological showcases but instead demonstrate how technology can be utilised to establish fair, inclusive, and ethically governed communities. The insights extracted from this critical review aim to trigger the discussion over solutions that balance technological innovation with urban environments that prioritise the well-being and dignity of all inhabitants. By following these guidelines, smart cities can fully realise their potential as a tool for positive societal transformation.

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#### REFERENCES

- [1] T. Singh, A. Solanki, S. K. Sharma, A. Nayyar, and A. Paul, “A Decade Review on Smart Cities: Paradigms, Challenges and Opportunities,” *IEEE Access*, vol. 10, pp. 68 319–68 364, 2022.
- [2] M. H. Laskar, “Examining the emergence of digital society and the digital divide in India: a comparative evaluation between urban and rural areas,” *Frontiers in Sociology*, vol. 8, 2023.
- [3] K. Hartley, “Public trust and political legitimacy in the smart city: a reckoning for technocracy,” *Science, Technology & Human Values*, vol. 46, pp. 1286–1315, 2021.
- [4] D. Pessach and E. Shmueli, “A review on fairness in machine learning,” *ACM Comput. Surv.*, vol. 55, no. 3, feb 2022.
- [5] S. Shin, D. Kim, and S. A. Chun, “Digital divide in advanced smart city innovations,” *Sustainability*, vol. 13, p. 4076, 2021.
- [6] K. S. Willis, “Whose right to the smart city?” *The Right to the Smart City*, pp. 27–41, 2019.
- [7] B. P. Ng, C. Park, C. Silverman, D. O. Eckhoff, J. C. Guest, and D. A. Díaz, “Accessibility and utilisation of telehealth services among older adults during covid-19 pandemic in the united states,” *Health & Social Care in the Community*, vol. 30, 2022.
- [8] T. Chen, J. R. Gil-García, and M. Gascó-Hernández, “Understanding social sustainability for smart cities: the importance of inclusion, equity, and citizen participation as both inputs and long-term outcomes,” *Journal of Smart Cities and Society*, vol. 1, pp. 135–148, 2022.
- [9] H. Mihaljević, C. J. Larsen, S. Meier, W. Nekoto, and F. M. Zirfas, “Privacy-centred data-driven innovation in the smart city. exemplary use case of traffic counting,” *Urban, Planning and Transport Research*, vol. 9, pp. 425–448, 2021.
- [10] D. Helbing, F. Fanitabasi, F. Giannotti, R. Hänggli, C. I. Hausladen, J. v. d. Hoven, S. Mahajan, D. Pedreschi, and E. Pournaras, “Ethics of smart cities: towards value-sensitive design and co-evolving city life,” *Sustainability*, vol. 13, p. 11162, 2021.
- [11] Z. Allam, “The emergence of anti-privacy and control at the nexus between the concepts of safe city and smart city,” *Smart Cities*, vol. 2, pp. 96–105, 2019.
- [12] P. Aragón, A. Kaltenbrunner, A. Calleja-López, A. Pereira, A. Monterde, X. E. Barandiaran, and V. Gómez, “Deliberative platform design: the case study of the online discussions in Decidim Barcelona,” *Lecture Notes in Computer Science*, pp. 277–287, 2017.
- [13] A. Christofi, “Smart cities and cumulative effects on fundamental rights,” *Internet Policy Review*, vol. 12, 2023.
- [14] D. Purves, “Fairness in algorithmic policing,” *Journal of the American Philosophical Association*, vol. 8, pp. 741–761, 2022.
- [15] M. Sapena, M. Kühnl, M. Wurm, J. E. Patino, J. C. Duque, and H. Taubenböck, “Empiric recommendations for population disaggregation under different data scenarios,” *PLOS ONE*, vol. 17, no. 9, p. e0274504, Sep. 2022.
- [16] E. Shirima and K. Ghazinour, *Towards Privacy-Aware Smart Surveillance*. Springer International Publishing, 2020, pp. 398–406.
- [17] M. P. Singh and P. K. Murukannaiah, “Toward an ethical framework for smart cities and the internet of things,” *IEEE Internet Computing*, vol. 27, no. 2, pp. 51–56, 2023.
- [18] K. Löuk, *Relevance and Challenges of Ethics Committees*. Springer Nature Switzerland, 2023, pp. 125–136.
- [19] K. Bednar, S. Spiekermann, and M. Langheinrich, “Engineering privacy by design: Are engineers ready to live up to the challenge?” *The Information Society*, vol. 35, no. 3, pp. 122–142, Mar. 2019.