REVIEW ARTICLE

Navigating Ethical Challenges in 6G-Enabled Smart Cities: Privacy, Equity, and Governance

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Abstract

The rapid urbanization and technological advancements have driven the development of smart cities, envisioned as sustainable, efficient, and interconnected urban spaces. The integration of sixth-generation (6G) wireless technology in smart cities promises unprecedented opportunities in connectivity, low-latency communication, and data management, which transforms urban living. However, this evolution raises critical ethical concerns related to privacy, inclusion, transparency, accountability, and environmental sustainability. This paper explores the ethical considerations inherent in designing smart cities with 6G, emphasizing data governance, equity, and human-centric approaches. It delves into frameworks such as utilitarianism, deontological ethics, and virtue-based ethics to address issues such as algorithmic bias, data privacy, and societal inclusion. The review highlights the challenges of ensuring equitable access to technology, minimizing surveillance risks, and fostering transparent decision-making in urban governance. It also underscores the importance of sustainable practices and environmental ethics, advocating for energy-efficient systems and the principles of circular economy in 6G-enabled urban ecosystems. By examining these dimensions, the paper offers actionable recommendations for stakeholders, including policymakers, urban planners, and technology developers, to balance technological innovation with ethical responsibility. This study serves as a critical guide to ensure that the future of smart cities is not only technologically advanced but also socially equitable, sustainable, and aligned with human dignity.

Keywords: smart cities, 6G technology, ethical considerations, privacy, inclusivity, data governance.

1 Introduction

Rapid urbanization across the globe has driven the development of "smart cities," which leverage cutting-edge technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and advanced wireless communication networks to create efficient, sustainable, and interconnected urban spaces. Among

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these technologies, the upcoming deployment of sixth-generation (6G) wireless networks promises to further revolutionize smart cities by enabling ultra-fast data speeds, ultra-low latency communication, and massive device connectivity. However, as these technologies advance, significant ethical challenges arise, particularly in the areas of privacy, equity, and governance [1].

With the growth of urbanization, smart cities have emerged as a revolutionary solution to urban challenges [2]. These cities leverage technologies to create interconnected environments, offering the potential for greater efficiency, sustainability, and an improved quality of life for their citizens. Central to this technological evolution is the forthcoming deployment of sixth-generation (6G) wireless technology, which is expected to significantly transform urban environments [3, 4]. While 6G remains a theoretical concept, its data rates are anticipated to exceed terabits per second (Tbps) under certain conditions. Additionally, super-reliable low-latency communications (SRLLC) and immense connectivity capacities offer the potential to enhance existing smart city use cases and introduce new ones that could revolutionize urban operations. However, the impending reality of this new level of interconnectedness raises critical ethical questions related to the design and implementation of 6G smart cities.

The data-driven nature of smart cities highlights the need for lightweight AI models that can efficiently process data from various IoT devices while minimizing computational overhead [5, 6]. Such models are crucial for building scalable and sustainable smart city infrastructures, allowing real-time analytics without straining communication networks. Smart Cities offer huge promises with the tight interplay between IoT, AI, and sophisticated communication networks, but also enormous ethical questions [7]. Smart cities will become more data-driven, bringing a threat around implications like how to collect, what to do with the data, and how to manage it. The enormous amount of data connected devices produce leads to important concerns related to individual privacy, consent, and data ownership. Citizens could be unaware subjects of surveillance and have their movements, preferences, and behaviors observed and analyzed [8]. Without balance and frameworks to uphold individual rights while utilizing the power of data for the benefit of all, this data-oriented approach may strip away autonomy [9].

In addition, the principles of equity and inclusion need to be the foundations on which smart city technologies are deployed. While urban planners incorporate 6G capabilities into the systems they design, this must not result in further amplification of existing inequalities or even new disenfranchisement [10]. Whether in developed or developing cities, a lack of skills and/or infrastructure may cause historically marginalized communities to be left behind in the race to develop smart cities [11]. This raises ethical issues such as access to technology, and the digital divide as well as potential social exclusion. Universal access to smart city programs and benefits is not just the right thing to do; it is an essential component of sustainable urban development [12].

Another ethical dimension that should be taken into consideration while designing smart cities is transparency and accountability. Citizens should be aware of what is done with their data and who is in charge of protecting it as technologies are rolled out [13]. Algorithmic decision-making processes make ethical considerations difficult because they can simply reproduce and reinforce already existing biases that recreate power structures. This shows that when citizens know who is responsible for making decisions, they can trust and be confident in their interactions with the smart city technologies [14]. It is paramount to ensure that the mechanisms for ethical governance are established and play a crucial role in creating not only smart cities but also protecting the rights of their citizens in an evolving technological world that is bound to expand.

Given these considerations, this review paper introduces a holistic examination of the ethical perspectives that require a specific reference in considering the design of smart cities using 6G [15]. By discussing some of the relevant ethical frameworks such as utilitarianism, deontological ethics, and virtues-based ethics, the review paper considers the possibility of using these ethical perspectives as a basis for the decision-making process. Besides, the review paper examines some of the most critical issues related to privacy and data protection with a particular reference to the ethical implications of data collecting and using them in smart cities [16, 17]. As a part of these considerations, the paper explores equity and inclusion as two intertwined fields and demonstrates the importance of the principles that can contribute to all individuals' access opportunities.

In other terms, the examined issues allow the paper to demonstrate the significance of the principles that can potentially ensure that all citizens obtain access to and representation in smart city projects.

This paper aims to explore the ethical implications of designing and implementing 6G-enabled smart cities, focusing on issues of privacy, inclusivity, transparency, and accountability. Specifically, it investigates how ethical frameworks can be applied to address these concerns and ensure that the potential benefits of 6G are realized in a socially equitable and environmentally sustainable manner. The significance of this research lies in its potential to guide the development of ethical frameworks that can be applied to future smart cities. By addressing privacy, inclusivity, and governance concerns, the paper advocates for a holistic approach to urban planning in the age of 6G technology [18]. The findings of this study have important implications for policymakers, urban planners, and technology developers, ensuring that smart cities are not only technologically advanced but also just, equitable, and sustainable.

The paper employs a literature review methodology, analyzing existing ethical frameworks such as utilitarianism, deontological ethics, and virtue ethics in the context of 6G-enabled smart cities. Case studies and examples from current smart city projects will also be explored to illustrate these ethical principles in practice. The paper makes a unique contribution by integrating ethical analysis into the discourse on 6G smart cities. By focusing on privacy, equity, and transparency, this research provides valuable insights into how 6G can be deployed ethically to benefit society as a whole.

Also, the review paper considers the opportunities that the deployment of smart cities' technologies creates in terms of ensuring the necessity of maintaining more transparency as a reflection of more accountability in the city government issues [19]. In this way, the paper discusses the ethical implications and issues to consider in terms of considering acceptable and unethical security measures as they relate to the issue of individual rights in the considerations of the specifically assigned 6G network [20]. The paper also considers some of the most critical problems and points of discussions that are raised as the principles of sustainability and environmental ethics and, among these issues, proposes the idea of how 6G can and should ensure that the emerging technology will contribute to the options of eco-friendly urban design. With proper regard to the ethical dimensions of the problems of developing smart cities, the final section introduces recommendations for stakeholders, policymakers, and design companies in terms of framing their approaches to creating viable urban environments. As a result, it becomes possible to make the starting point of the reflection on the issues of designing smart cities that the present globe should act responsibly and that their decisions and choices taken now will be shaping the destiny of the cities of tomorrow [21]. It is indispensable to remember that the devotion to stimulate technological progress should, in this way, be mitigated by the same level of responsibility reflecting an ongoing responsible reflection on the ethical implications of the smart city projects [22]. Therefore, the life in the future, powered by the 6G network is in our hands and our responsibility by now is to set the conditions for ensuring the environment focused on an arguably better degree of human dignity for all, social benefits for all, and the option for all to develop and grow. The success of the smart cities of the future definitely depends not only on the quantum leaps in technology but also on the quality of the choices made to address all the ethical challenges inevitable on such a large-scale way of cultural and economic transformation [23].

The design and implementation of smart cities will have significant long-term impacts on the lives of millions of people. It is essential to ensure that smart cities are developed in a manner that provides tangible value to society. In addressing the complexities of this issue, it is crucial to recognize the ethical responsibility to current and future generations who will inhabit these urban environments. This review paper aims to serve as a foundational reference for a critical examination of the ethical considerations surrounding urban technological innovation. It emphasizes the need for creating smart cities that are not only technologically advanced but also just, equitable, and sustainable [24].

1.1 Challenges in 6G-Enabled Smart Cities

As the deployment of 6G technology in smart cities progresses, several ethical challenges emerge, necessitating careful consideration. The ultra-fast connectivity, massive data collection, and AI-driven automation embedded in these urban ecosystems introduce significant concerns regarding privacy, digital inclusion, governance, and sustainability. Addressing these ethical dilemmas is critical to

ensuring that technological advancements benefit all citizens equitably and do not exacerbate existing societal disparities. Without appropriate frameworks, the deployment of 6G smart cities could lead to unintended consequences, such as increased surveillance, algorithmic discrimination, and digital marginalization. Moreover, the governance of such vast interconnected networks requires a transparent and accountable approach to mitigate risks related to biased decision-making, data breaches, and environmental degradation. Below are some of the key ethical challenges that must be addressed:

- The extensive use of AI and IoT devices in smart cities generates vast amounts of data, raising concerns about personal privacy, consent, and the potential misuse of sensitive information. Unchecked surveillance mechanisms could infringe on citizens' rights, leading to ethical dilemmas regarding autonomy and security.
- AI-driven decision-making in smart cities, including facial recognition and automated resource allocation, may unintentionally reinforce biases. Such biases can lead to discrimination against marginalized communities, exacerbating the digital divide and creating barriers to equitable access.
- The governance of 6G-enabled smart cities involves complex decision-making processes where algorithmic transparency is essential. Lack of clear accountability mechanisms could result in opaque governance structures, making it difficult for citizens to understand and challenge decisions affecting their lives.
- The deployment of 6G infrastructure requires significant energy consumption and resource allocation. Without sustainable practices, smart city technologies could contribute to environmental degradation, contradicting the goal of creating eco-friendly urban environments.
- As cities become more interconnected, the risk of cyberattacks on critical infrastructure increases. Safeguarding sensitive information from breaches and ensuring robust cybersecurity measures are crucial to maintaining trust in smart city initiatives.

Addressing these challenges requires a multidimensional ethical framework that integrates privacy safeguards, equitable access, and sustainable governance models. By acknowledging and mitigating these risks, 6G-enabled smart cities can be developed in a manner that prioritizes human rights, social equity, and environmental sustainability.

Contribuations

- Integrates ethical frameworks (utilitarianism, deontology, virtue ethics) to address challenges in 6G-enabled smart cities, offering a balanced approach to technology and ethics.
- Highlights privacy, equity, and governance issues in smart cities, proposing solutions to ensure fairness, transparency, and inclusivity.
- Explores sustainability and environmental ethics in 6G urban designs, advocating for eco-friendly practices and circular economy principles.
- Provides actionable recommendations for policymakers, urban planners, and technology developers to build ethically responsible smart cities.
- Uses case studies to demonstrate practical applications of ethical principles in existing smart city projects.
- Identifies research gaps and suggests future directions for ethical governance, algorithmic fairness, and inclusive smart city development.

Through this understanding, we can facilitate the ethical development of smart cities and provide more human-centered urban spaces. Realizing the potential capabilities of 6G on smart city design is a journey that requires us to pay close attention, practice consistent dedication, and focus on ethics as we process through an ever-connected world.

2 Material and Methods

We used a modified systematic review methodology to explore the ethical challenges in designing and implementing 6G-enabled smart cities, with a particular focus on issues of privacy, equity, governance, and sustainability.

2.1 Search Strategy and Inclusion Criteria

The data for this study was collected from several electronic databases, including IEEE Xplore, Science Direct, and Google Scholar. The search covered literature published between 2018 and 2024. The search terms included "6G technology," "smart cities," "privacy in smart cities," "data governance," "algorithmic bias," and "equity in urban planning." We

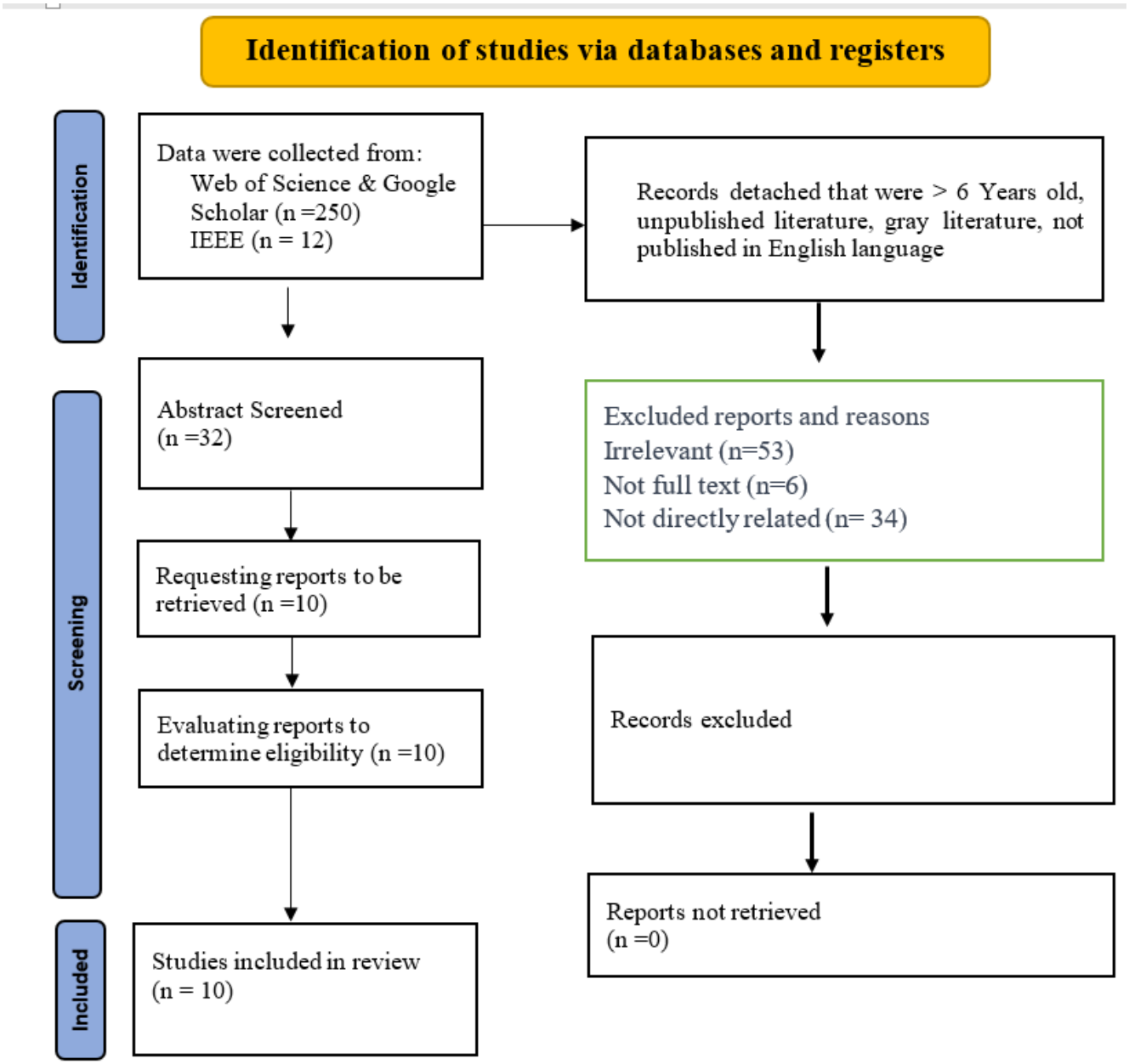


Figure 1. The study selection process is depicted in the PRISMA flow diagram.

included research articles that addressed ethical issues in the design, deployment, and governance of smart cities using 6G technology. Articles published before 2018 or those that were not directly related to 6G in smart cities or ethical considerations were excluded from this study as shown in Figure 1.

2.2 Data Extraction and Quality Assessment

Data was extracted from relevant studies to identify key ethical challenges associated with 6G-enabled smart cities. The extracted data included study design, research focus (privacy, equity, governance, sustainability), findings related to ethical implications, and proposed solutions.

2.3 Search Outcomes

In this study, 262 research articles were initially identified through the search of multiple databases, including Web of Science, IEEE Xplore and Google Scholar. Articles were screened for relevance based on the inclusion and exclusion criteria, which focused on the ethical implications of 6G technology in smart cities. After applying these criteria, 10 articles were selected for final review. These articles included empirical studies, systematic reviews, and theoretical papers discussing privacy concerns, equity, transparency, and governance in 6G-enabled urban environments. The final selection was based on relevance to the topic of ethical issues in smart city design and the potential

implications for stakeholders involved in the planning and implementation of 6G technologies.

2.4 Quality of Data Collection

A comprehensive search was conducted in multiple databases to identify studies published between 2018 and 2024 that focus on the ethical aspects of 6G technology in smart cities. The search strategy included terms such as "6G ethics," "data privacy in smart cities," "algorithmic decision-making," and "inclusive urban planning." Articles related to general technological advancements or those without a direct focus on ethical challenges were excluded.

3 Understanding Smart Cities

Smart cities are developed urban areas that use various types of electronic data collection and communication to improve infrastructure, services and living conditions [25]. They utilize data-centric solutions and automated systems for better handling of transportation, healthcare, energy, and public services [26]. Smart cities are known for building sustainability, they emphasize innovative methods that discard waste and inefficient consumption of resources and reduce environmental effects. With this level of connectivity, information can flow freely and capture the real-time status providing a responsive ecosystem where urban challenges can be addressed rapidly.

Skubis et al. [27] conducted a study on AI and Human-Centric Approach in Smart Cities Management: Case Studies from Silesian and Lesser Poland Voivodships. They explore the extent to which Artificial Intelligence (AI) is facilitating smart city management. The study aims to compare the local/regional AI strategies in two urban agglomeration areas: Silesian and Lesser Poland Voivodships, on matters of efficiency, sustainability and quality of life. From a methodological perspective, the study is built on case studies to compare AI usage in different fields, ranging from traffic management and healthcare to environmental management. The results highlight the industrial profile of Silesian region while in Lesser Poland industry branches are diversified and also cover life sciences and ICT applications [28]. The research emphasizes a human-centered approach to their growth, calling for ethical transparency and inclusivity in the growth of smart cities [29]. In conclusion, the authors suggest directions for future research that explores socio-technical dynamics in implementation of AI use-cases in urban management to distribute benefits equitably and to develop more sustainable cities. The concept of smart cities with 6G Network is shown in Figure 2.

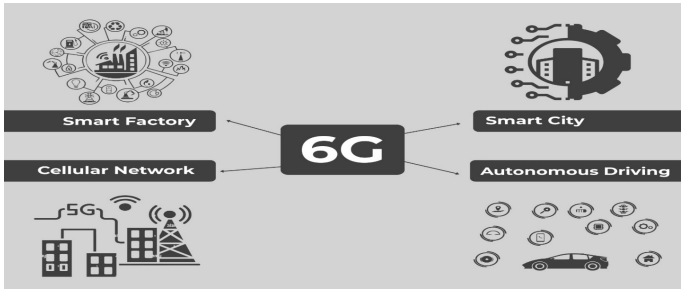


Figure 2. A concept of smart cities with 6G network.

The Internet of Things (IoT) is an important part of smart city design as it allows for networks of sensors and devices to communicate with one another in real-time by collecting and transmitting data [30]. With the advent of 6G, it is expected that this technology will maximally enhance the abilities of IoT devices by providing ultra-fast data speeds, low latency and communication with a large number of connected devices. This advanced communication technology will enable applications such as self-driving cars, interactive AR devices, and proactive health care systems that require faster response times, making cities even smarter and more responsive [31]. Khaloopour et al. [32] introduce the concept of "resilience-by-design" (RBD) as a framework for developing robust 6G communication networks. The research aims to address potential disruptions such as technical failures, natural disasters, and terrorism, by embedding resilience principles across various components of 6G infrastructure. The German Open6GHub project encompasses this study. An extensive literature study followed by inter-disciplinary analysis is included in the methodology to establish principles that enable RBD and which span across multiple layers of n-works. The research found that incorporating RBD into electronics, physical channels, network services and infrastructure has to be done to keep things running operationally [33]. These principles applied in the real world are illustrated through a few 6G use case examples. The authors outline a few directions for future research, including streamlining RBD frameworks and broadening cross-layer resilience initiatives to strengthen the resiliency of next-generation networks as an open problem [34].

Smart cities bring advantages on many fronts, from operational efficiency to sustainability and citizen

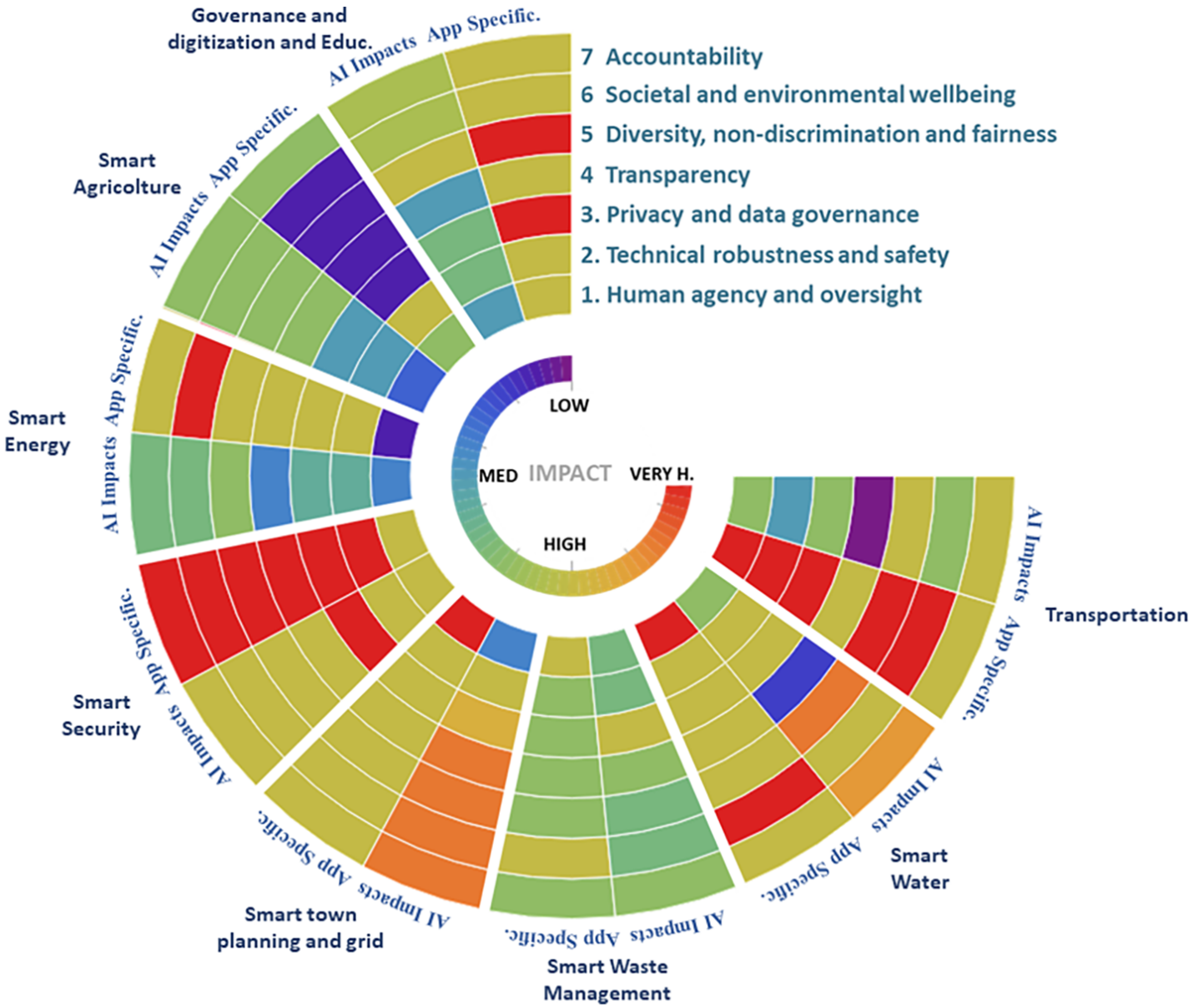
wellness [35]. Smart traffic systems have the ability to alleviate congestion and reduce air pollution, while smart grids can facilitate better energy distribution: all of this translates into huge cost savings and advantages for the environment. Furthermore, 6G will enable better connectivity and help deliver more inclusive public services to citizens accessing health, education and other essential services remotely. In summary, the goals of smart cities is to achieve an optimal balance between technological innovation, sustainability and human-centered urban development [36, 37] to provide a foundation for communities ready for the changes of tomorrow. Gunawan et al. [38] focuses on using AI to facilitate the urban design process through a salutogenic approach, which emphasizes environmental and human well-being. It shows that it can reduce the time taken to design cities while also providing sustainability via biomimetic and vernacular architecture, multilevel pedestrian infrastructure, and green energy solutions. Dubbed "Toward Tomorrow's Sanctuary," the idea is in keeping with sustainability, needs of people, nature compatibility, and tech-compatibility. It finds that while AI greatly improves urban design, there is always an ethical concern that can only be addressed locally with human-centred input [39]. Our future work will involve the refinement of these AI approaches to more closely parallel ethical urban planning standards.

4 Ethical Frameworks for Smart City Design

They offer a crucial compass for smart city design, facilitating the primary goal of making technology advancements compatible with societal values [40]. For instance, utilitarianism focuses on maximizing overall good and pushes city planners to make choices that benefit the most people. Some of tasks in smart city context might include: implementing technologies to optimize traffic management, or deploying newer technology for reducing energy consumption and make cities more efficient [41, 42]. Although this utilitarian approach of maximizing global benefits is compelling, it may come at the expense of treating members of potential minority groups unfairly due to their lack of representation in these calculations. It might also violate their rights by prioritizing the greater good over those needs, so legal frameworks based on concepts other than utility need to address that issue. They are critical of the technocratic nature of many smart city initiatives and call for participatory design with those whose voices are often excluded: migrants, refugees, older adults, children, neurodiverse individuals and people with low income. The current tendency towards developing and implementing smart solutions within the urban setting has driven the literature on smart cities as technological archetypes. The inclusion of these diverse stakeholders promotes an inner urban setting that is non-technocratic, inclusive, well-being enhancing and sustainable. The study also calls for planning for animals and nature, arguing that holistic smart city development must integrate ecological and social dynamics [43]. This fruitful approach yields the sustainable and integrated smart city model for all citizens with great attention to vulnerable groups [44]. The visual model for ethical impacts framework is shown in Figure 3.

Deontological ethics is rule-based and action-determined, stating that some actions are required no matter the outcome. For example, within the smart city context, a deontological approach may underscore the importance of privacy protections – Citizens are entitled to have their personal data protected and should not be subjected to exploitation even if it means society forgoing valuable insights from such data. In a similar vein, virtue ethics focuses on the notion of moral character and thereby takes the meta point towards design decisions that align with values such as fairness, empathy, and transparency; all of which are needed to create trust between citizens and governing bodies.In this regard, their work shows the often unfortunate consequences of using algorithms to optimize for a given outcome (it introduces biases and leads to discrimination: applicants of color who would otherwise have succeeded had lower success rates). To combat these kinds of ethical problems, they propose embedding specific definitions of social objectives such as fairness and privacy directly within the designs of algorithms. Differential privacy is introduced as a way to preserve the anonymity of individuals, certifying that data from other datasets or portions do not enable the identification of personal information. The authors suggest that fulfilling these social objectives may come at the price of a certain amount of efficiency and betoken equity over efficiency. This makes their work to embed ethics into algorithmic frameworks to avoid harm and ensure other socially beneficial properties timely and highly relevant.

Engagement with stakeholders is crucial and proportional to the application of these ethical frameworks [45–48]. Smart city projects involve a multitude of stakeholders like government officials, citizens, and technology vendors, each with distinct



Source: Authors' own creation

Figure 3. Ethical impacts framework: visual model [48].

interests and perspectives. Balancing conflicting needs and priorities keeps governance ethical, engaging all stakeholders in the decision-making process. An open and inclusive discourse can expose risks, mitigate against unwanted negative externalities, and assure that smart city technologies are implemented in the public interest according to urban spaces embodying common values as long-term sustainable development. Shahrokni et al. [49] introduce the concept of "real-time ethics" in smart city environments, emphasizing the need to empower citizens through technology-enabled participation. The study postulates that Information and Communication Technologies (ICT) can improve sustainability by allowing people to play an active role in urban development. [50] Taking inspiration from behavioral psychology, they look at how citizens can be provided with real-time decision-making tools that make clear their own contributions towards the overall sustainability objective. One concern about this change is the cognitive load that comes from citizens needing to make ethical decisions regularly. According to the authors, however, "As this transition takes place, it needs to be tread carefully - too much decision-making power in citizens' hands may backfire." The study highlights the importance of interdisciplinary ways of working to steer ethical smart city design and ensure that the burden of

sustainability is not borne solely by one part of society.

5 Privacy and Data Protection

Data is the key driver of smart cities, enabling it to make urban life better through more effective public services and urban resources [51, 52]. Everything from traffic jams to energy use and healthcare indicators is constantly observed by sensors, cameras, and connected devices. Such a treasure trove of insights empowers city administration to make informed choices, anticipate patterns and proactively tackle problems. But, then there is the quantity of individual information profiled from different angles: what individuals do where they go – all that turns out to be clear to public and private players alike. As exposed through literature reviews, qualitative case study analysis and interviews with stakeholders. It suggests stronger policy frameworks and partnership between public and private sectors while monitoring the consequences of such technology to allow AI in France to become a sustainable and fair tool for urban development. The results reveal the need to facilitate AI for better urban living by tackling privacy, data protection and balanced access to technology. The framework proposed by [53, 54] for privacy protection in 6G based on public-key searchable encryption as shown in Figure 4.

One of the main ethical issues in smart cities is related to the collection and use of people data without their consent [55]. Citizens may sometimes not realise the breadth of their data collection and processing, which can lead to misuse or exploitation. No control over personal information also leads to the problems of surveillance or monitoring, in which a data-driven system can threaten citizen liberty. Additionally, biases in data collection processes themselves can reinforce existing inequalities by affecting some groups more than others. So, ethical data governance is about providing transparency around the way in which data are used and ensuring that the consent was given freely and informed. Bouramdane [56] focuses on the role of advanced technologies in disaster management for smart cities, employing Multi-Criteria Decision-Making (MCDM) and the Analytical Hierarchy Process (AHP) as tools to evaluate and prioritize disaster management strategies. The mesh of connected infrastructure in smart cities makes them more vulnerable to natural and humanmade disasters, cyber and other attacks [57, 58], and climate-related hazards. The examination focuses on improving resilience and communication redundancy as crucial components of disaster management strategies. Additional considerations such as accuracy and timeliness, scalability, cost-effectiveness, ethical implications, and the requirement of continuous training serve to complement other factors. It highlights the need for citizen vigilance and early warning, as well as integrated communication to reduce risks from natural disasters. AI algorithms, IoT-enabled sensors, drones and resilient infrastructure design add icing on the cake. These findings have practical implications for urban planners, policymakers, and disaster experts by suggesting that planning strategies need to be top aligned with critical touch points in a community. Ensuring data privacy and protection is fundamental throughout the process so that technology based solutions not only equip us with better capabilities to prepare for and respond to disasters but also secure citizen information.

At the same time, privacy protection in smart cities can be achieved through practical application of technology without undermining rights. Data-protection measures like anonymization, data minimization and data encryption may help mitigate the impact of a potential data breach or unauthorized access. Patients expect their most sensitive data to be protected, and privacy-by-design principles should be put in place to ensure privacy is built into the systems rather than thought of after. Also, the establishment of clear rules for sharing data and accountability increases citizen trust towards governing institutions. Ahmad explained regulatory regimes, such as GDPR, can help cities create ethical data practices that provide users their privacy while still getting us smart city benefits.

6 Equity and Inclusion

Equity and inclusion are another abdication standard for smart city design and implementation: Everyone should benefit from these advances in technology, regardless of their socioeconomic situation, geographic location, or actions taken throughout the pandemic. But the digital infrastructure that supports smart city initiatives is not equally accessible to all segments of society. To address these gaps, one must consciously work towards eliminating the barriers that persist in access to technology for those at a disadvantage: poor infrastructure, low or maladmissible digital skills, and financial incapacity. If smart cities are not approached carefully, they may only target already privileged citizens, pushing the most vulnerable even

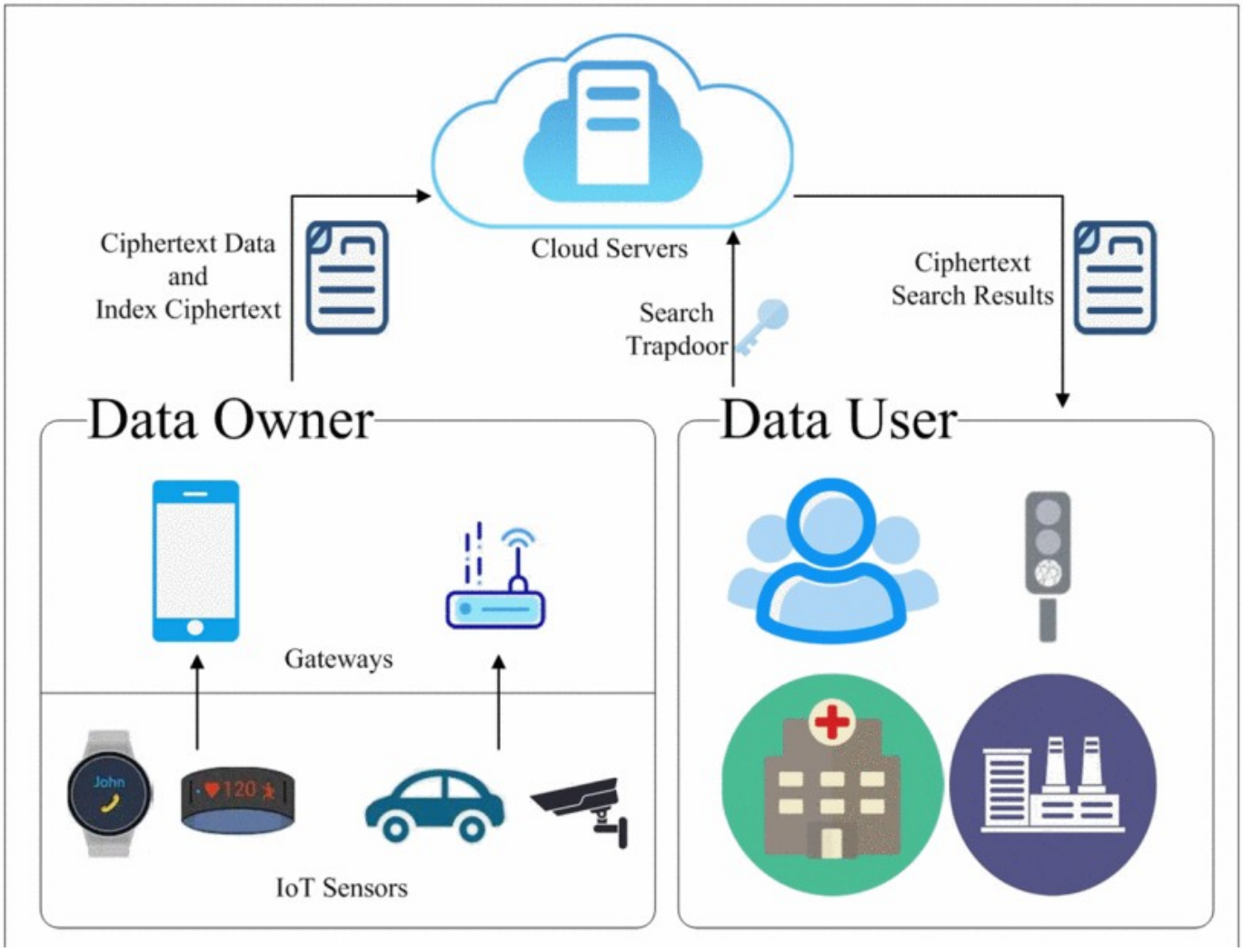


Figure 4. The framework of privacy protection in 6G based on public-key searchable encryption [54].

further behind. Kumar et al. [59] These being Intelligent traffic management systems using AI: A review of applications in smart cities for smart urban transportation. According to their findings, the research highlights that congestion can be addressed more effectively with advanced traffic management systems which make use of real-time data along with predictive algorithms and dynamic routing. Some of the challenges linked to this kind of massive deployment in urban applications are success limiters and are potentially going on bigger issues around scalability, interoperability,or ethics. It suggests the possibilities in accumulation of AI driven traffic management with town planner achieve functional feasibility results for solid transportation networks and contribute towards smarter infrastructure within cities [60].

The use of sophisticated technologies in smart cities are likewise centre stage for ethical issues, particularly against marginalized groups [61]. Data-driven systems can make public services more efficient, but they can also inadvertently build biases into the technologies that disadvantage some populations. Predictive algorithms, such as those used in policing or social services, can mirror past injustices and discriminate against particular communities or reinforce old biases. Likewise, the so-called surveillance tools like cameras although meant to secure cannot make algorithms immune from discrimination and oppressed communities is even more subjected to intensified surveillance. These risks must be addressed to ensure that technologies deployed in smart city programs are done so in ethical and non-discriminatory ways. Ertl et al. [62] take a critical stance towards smart cities, while considering the participation of marginalized and vulnerable populations -non-city dwellers such as refugees or neurodiverse communities and the inclusion/exclusion effects on (potential) city dwellers - low-income groups are often excluded from

mainstream planning processes providing limited challenges to issues of social equity in high-tech megacities. The Design Fiction workshop emphasises the necessity of participatory design and stakeholder engagement to make sure that smart city initiatives are not technocratic but are truly in the interest of multiple stakeholders. It highlights the importance of citizen-oriented approaches to foster sustainable and social equity for smart cities. It suggests that a belief in an open, comprehensive view is needed to tackle the challenges of urban life and to ensure that advances in technology support all citizens, especially those most vulnerable.

Likewise, Suneetha et al. cite63 put forward a framework that combines AI and blockchain to further improve the performance of smart cities IoT applications in regard to 6G. By suggesting decentralized control using blockchain technology, their study tackles issues of security, privacy and data management in large-scale IoT systems. A combination of qualitative and quantitative metrics are used to assess the potential benefits of the working framework over established methods. According to the authors, the combination of AI and blockchain opens a new door for more effective management of complex urban infrastructure while providing better measurable performance in IoT-enabled smart city applications.

In sum, the multi-dimensional approach to promoting inclusion in smart city initiatives: To start, policy makers and city planners should work with marginalized communities at every step of the decision to sort out their needs, challenges, and hopes. Such participatory design frameworks also guarantee the creation of tech solutions with input from all stakeholders, especially those often marginalized in discussions around urban planning. Second, cities should implement programs to advance digital skills, provide low-cost access to the Internet, and offer smart offerings to bridge the digital divide. Lastly, our smart cities of the future will need to have regulatory frameworks that require ethical audits of all technologies used on citizens and surveillance data in key areas such as healthcare and public services to avoid unintended harm, ensure equity, and prevent discriminatory outcomes. By following these strategies, smart cities can create an environment that is inclusive of all citizens who need access to technology and provide them with meaningful participation in the urban ecosystem.

As shown in Table 1, various research studies have explored the ethical, technological, and governance challenges associated with 6G-enabled smart cities. These studies examine key areas such as AI-driven urban management, resilience-by-design frameworks, and the role of AI in sustainable urban planning. Additionally, they highlight concerns related to privacy risks, digital divides, and ethical governance, emphasizing the need for transparency and accountability. Furthermore, emerging solutions such as AI-blockchain integration for IoT security and real-time ethical paradigms for citizen participation are discussed. Collectively, these findings underscore the importance of interdisciplinary approaches to balance technological advancements with ethical considerations, ensuring that future smart cities remain inclusive, sustainable, and ethically responsible.

7 Transparency and Accountability

Smart cities are modern urban centers rapidly developing with technologies designing service delivery, infrastructure and engagement to citizens but it must be balanced out with these ethical aspects like Transparency and accountability. Transparency helps residents and stakeholders know how the technologies are implemented, what data is collected and used, and what outcomes to expect. To facilitate trust and ensure that the public does not react with scepticism or resistance to these initiatives, it is essential for cities to openly communicate about their technology deployment in smart city systems because they are very complex. Transparency is particularly important in decision-making contexts where data practices and algorithms shape the decisions made by, or input into urban sensing systems, as these practices can be complex and opaque. With a greater understanding of how urban governance works, through more transparent city strategies for public participation, citizens gain a clearer sense on how they can engage meaningfully with their local governments and make informed choices about whether, and to what extent they choose to participate. Accountability is also about ensuring that ethical and equitable decision-making is followed. Asteroids in smart cities where your algorithms and automated systems are going to be what make critical decisions in traffic control and public safety, among other things, we need to do the hard work of determining who is accountable for outcomes. The absence of clear accountability frameworks can lead to negative consequences not receiving any repercussions

Table 1. Summary of research studies in the literature (Landscape Orientation).

Author (Reference)	Objective	Methodology	Key Findings	Future Work
Skubis et al. [27]	Explore AI's role in smart city management	Case studies from Silesian and Lesser Poland Voivodships	Highlighted human-centric approaches to improve sustainability and efficiency	Examine socio-technical dynamics in broader urban AI applications
Khaloopour et al. [32]	Develop "resilience-by-design" (RBD) framework for 6G networks	Literature review and interdisciplinary analysis	Demonstrated resilience principles for 6G components to handle disruptions	Streamline RBD frameworks and explore cross-layer resilience initiatives
Gunawan et al. [38]	Use AI for salutogenic urban design in Indonesia	Qualitative exploratory study and literature review	Showed potential of AI for sustainable and health-centered urban designs	Refine AI approaches for alignment with ethical urban planning standards
Kumar et al. [59]	Review AI-driven traffic management systems for urban mobility	Literature review	AI improves congestion management and scalability; ethical issues persist	Focus on integrating AI traffic systems with participatory urban planning
Suneetha et al. [63]	Propose AI and blockchain integration for IoT in 6G-enabled smart cities	Combination of qualitative and quantitative assessment	Demonstrated improved performance in large-scale IoT systems with enhanced privacy and security	Test and refine framework for real-world large-scale IoT deployments
Shahrokni et al. [49]	Introduce real-time ethics paradigm for sustainability in smart cities	Behavioral psychology-inspired framework	ICT-enabled participation empowers citizens but risks cognitive overload	Explore interdisciplinary approaches to balance citizen empowerment with decision-making load
Bouramdane [56]	Enhance disaster management in smart cities using MCDM and AHP tools	Analytical hierarchy process (AHP)	Highlighted the need for resilience, communication redundancy, and citizen vigilance	Develop integrated communication systems for disaster risk reduction in smart cities
Chang [47]	Analyze ethical dimensions of algorithm design in societal decisions	Case analysis and algorithmic evaluation	presents an ethical framework for Big Data and Smart cities	Test socially aware algorithms in diverse societal contexts
Oliveira et al. [37]	Examine human-centered approaches for addressing security and ethical challenges	Critical analysis of smart city data governance	Gaps in inclusivity and transparency	Expand research into AI-empowered smart city governance

things like biased algorithms or data breaches. Governance must ensure that neither city officials nor technology providers escape accountability for their actions, reaffirming the primacy of public interests. Accountability also includes how fail-safes are built into when technologies develop irreparable problems or unintended consequences, so as not to punish one human being or group of beings over another. Although the possibilities that AI offers in improving urban life are immense, Ejjami maintains that it can be successful only if there is a seamless integration with existing structures and equal access to technology. The research highlights the importance of comprehensive policy infrastructure, effective public-private collaborations, and ongoing surveillance to ensure the positive influence of AI solutions on sustainable urban evolution. The results call for a nuanced deployment of technology, taking into account the potential value and social inequities that may result from smart city efforts. A transparent and accountable governance framework should be adopted by the cities. In these frameworks, there should be some open data policies (non-sensitive city data is open for public use and innovation) Also, smart city projects should have open procurement processes, and the specific technologies used and their purposes should be made known to the public. Technologies must meet public values new laws can help by increasing independent audits of algorithms and systems, which increase the likelihood that biases will be detected and acted on. Moreover, participatory governance models - ones where residents are empowered to participate in decision-making - will strengthen accountability by establishing direct lines of communication between citizens and city governments. In this way, smart cities can help to guarantee that technology contributes wisely we love urban living and advanced informal ongoing interaction to further develop.

8 Security and Ethical Concerns

Security is one of the critical aspects of smart city design that utilizes various interconnected technologies to manage urban systems and process huge amounts of data [64–66]. However, deploying security measures in smart cities creates a number of ethical issues. Surveillance technologies, for instance, are frequently justified as needed to increase public safety but may risk privacy and civil liberties. When cameras, facial recognition technology, and sensors are permanently watching our every move, it fosters an atmosphere of ubiquitous surveillance that erodes trust in the relationship between society and those acting on behalf of its interests. Likewise, securing smart city data is also problematic since a breach or exposure of sensitive personal information could put residents at risk for identity theft, fraud, or other targeted attacks.

9 Sustainability and Environmental Ethics

Smart city design is characterized by its focus on sustainability and environmental ethics, urging the need for balancing technological innovation with stewardship of the environment. While it is clear it will be broader in application as cities utilize to help make automated infrastructure, this also must abide within the context of sustainable practices in order for resource consumption and carbon footprints to hit holistic health levels. Making urban planning ethics not only use energy and material more efficiently but also a matter of thinking about sustainable environmental impact in the long term. Urbanization cannot threaten our environment and therefore, smart cities need to take up green practices including energy grid optimization, public transport promotion and waste reduction. A simple but similar connection of future smart cities with 6G network is shown in Figure 5.

From the sustainability standpoint, it will support new innovations like smart grid, and green energy monitoring efficiencies in precision farming with 6G technology [67]. By enabling instantaneous data transfer between multiple urban systems through improved connectivity and latency, 6G has the potential to optimize energy consumption from residential buildings and public utilities, curb traffic related emissions and encourage sustainable modes of living. For example, 6G sensors will help cities awaken to monitor air quality and to real-time read for much water consumed and waste levels indicating an over-exploitation of resources. The advantages, though, will only come if 6G technology is designed and utilized ethically, as an enabler of sustainability rather than a perpetrator of environmental destruction. Even though 6G holds promise in applying technology for sustainability, new technologies always present new environmental challenges, like electronic waste and greater energy requirements. The base station energy consumption accounts for a large part of the 6G network energy consumption, and the construction and maintenance infrastructure (e.g., data centre, antenna) of 6G networks would also greatly increase energy consumption. The curse of fast-changing

devices in smart cities is another challenge adding e-waste and pollution. Given all the ethical aspects, cities have to use circular economy stages to recycle, reuse and repurpose technology parts whenever it is possible. In addition, working on energy-efficient systems and emphasising renewable energy resources can help to eliminate the environment returns needed for technology use. Through the balance of innovation and ecological responsibility, smart cities can accomplish sustainability targets, all while ensuring there is an original living environment for future generations.

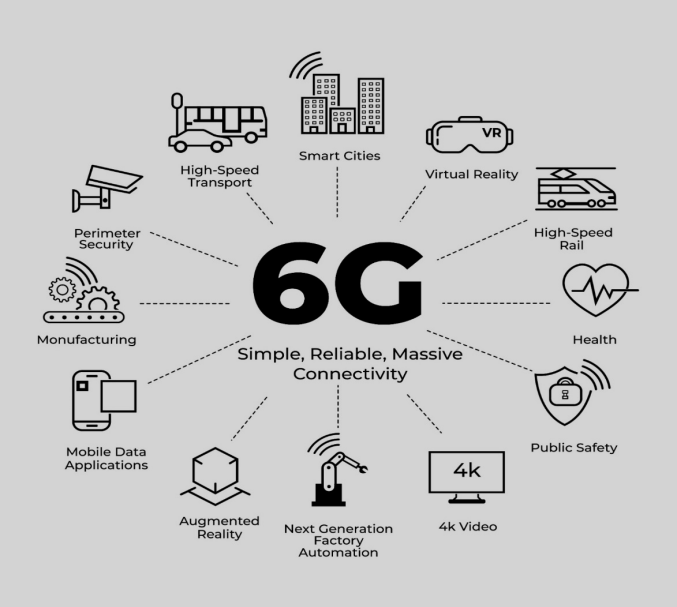


Figure 5. Future of smart cities design with 6G network.

10 Future Directions and Recommendations

Utilizing 6G technology to build smart cities in future requires addressing several ethical issues. The rapid growth of 6G technology, which extends the possibilities for interconnected systems and continuous data exchange in real-time will exacerbate problems related to data privacy, security, inclusiveness, and algorithmic bias. Develop frameworks with policymakers, designers, and stakeholders to ensure the responsible use of AI and data while reducing risks of surveillance technology and privacy infringements. Inclusiveness needs to be promoted through the inclusion of marginalized communities so that smart city technologies benefit all societal segments and do not reproduce existing inequalities. It recommends stakeholders create visible regulatory frameworks to react to the adoption of technologies being integrated into existing regulations. User-centred methods should be a design principle for designers, and citizens should be involved through participatory design. It is, thus, for policies to enforce an ethics oath for innovation that weighs citizens' rights against further exploration in any technology that serves such great potential, if operated within the scope of social value. Last but not least, public-private partnerships should be reinforced in order to sustain and advance responsible innovation in cities. As the technologies behind smart cities change and improve over time, constant ethical contemplation is needed in any smart city initiative. Continuous evaluation of the impact of innovative solutions enabled by 6G is needed to mitigate emerging ethical challenges. Integrating ethical audits, design processes situated within ongoing stakeholder feedback channels, and adaptive governance mechanisms can ensure cities have the adaptability to manage equilibrium of techno-social change.

The challenge of ensuring an appropriate balance between safety and freedom is one of the most problematic ethical dilemmas surrounding smart city security. Although sophisticated security systems may prevent crime and keep public areas safe, citizens fundamental rights should never be violated in tradeoff for such security technology. Klopp, the head of GRN's community-driven Liberty BtM data platform, warns that this "overreliance on surveillance or invasive data practices risks authoritarian systems where supposedly nobody has sex without permission" In and of themselves, the answer to these dilemmas requires ethical security practices that do not only consider the effectiveness of technologies but their social impact on violence and security. It means that safety measures must avoid having disproportionately adverse effects on people from specific communities or lead to discrimination. As solution smart cities need to strike a balance between security and inclusion, ensuring that surveillance is not deployed against marginalized populations. In order to mitigate this ethical quagmire, designers of smart cities can implement security strategies that are intertwined with democratic values and human rights principles. Security systems should be built with privacy-by-design principles, collecting as little data as possible and anonymizing it when feasible. But transparency about surveillance and data collection enables residents to know how their data is treated, alongside opportunities for public scrutiny. Additionally, assembling multiple stakeholders to ensure the development of security frameworks with local governments, civil society and technology

providers helps align security requirements with public interests. Audits, impact assessments and citizen feedback mechanisms on security measures will allow accountability in the long term, adaptability over time and ethical application. These initiatives enable smart cities to create secure spaces that honour public health while respecting privacy and civil liberties, and will lead to trust and sustainable urban resilience.

11 Conclusion

We have examined the ethical implications of utilising 6G technologies in developing smart cities in this review paper. The discussion included the use of AI and IoT-driven solutions to make urban living optimized, sustainable, and safer. On the other hand, this rapid growth also raises serious ethical questions related to privacy of data, bias in algorithms and possibility of increasing social inequalities. In this review paper, we have emphasized why it is crucial to weave ethical considerations into the design and implementation of smart cities. Stakeholders need to tackle these challenges head-on through transparency, inclusivity, and accountability at each step of smart city development. We have to develop ethical systems that adapt to rapidly changing technology to avoid a cycle of environmental destruction and tech-secessionism from urban life. This nuanced review paper emphasizes the importance of raising ethical consciousness in how 6G technologies are implemented into smart cities. We, as policymakers, designers and citizens must work together to forge urban solutions that reflect our values of fairness, privacy and inclusivity. Learn more about that balance how to innovate smart cities using 6G technology without betraying city residents' rights. With the correct application of ethics, smart cities powered by this next generation of tech can indeed improve life for all citizens.

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