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OPPORTUNITIES, CHALLENGES, AND RESPONSE PATHWAYS FOR URBAN MANAGEMENT IN THE AGE OF ARTIFICIAL INTELLIGENCE

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Abstract: Artificial intelligence is profoundly reshaping the paradigm of urban governance. On one hand, AI brings efficiency gains, resource optimization, and enhanced resilience — automated administration, precise services, and intelligent operations make cities run more efficiently. On the other hand, the accompanying risks cannot be ignored: algorithm optimization, responsible data governance, transparent decision-making, and inclusive digital development. These challenges highlight the importance of balancing technological innovation with public values. To overcome this predicament, a shift toward a people-centered governance paradigm is needed, where human-AI collaboration and inclusive governance establish a dynamic balance between efficiency and equity, innovation and regulation.
Keywords: Artificial intelligence; Urban management; Intelligent governance; Algorithmic risk

1 INTRODUCTION

Cities are the concentrated expression of human civilization and the most important arena of modern state governance. Entering the third decade of the twenty-first century, a new generation of information technologies represented by artificial intelligence is embedding itself into every aspect of urban operation with unprecedented depth and breadth.

At the end of 2022, ChatGPT burst onto the scene, surpassing 100 million monthly active users in less than two months and becoming the fastest-growing application software in history [1]. In early 2025, the DeepSeek series models released by DeepSeek, leveraging disruptive innovation and open-source strategy, lowered the threshold of use and quickly triggered a nationwide wave of "DeepSeek + government affairs," with a large number of local governments competing to integrate large models into their administrative systems for government consultation, intelligent office work, community management, and emergency response[2]. Scholars have observed that the large-scale deployment of DeepSeek by local governments marks a leap in AI from "instrumental assistance" to "generative agency," and the landscape of government service scenarios has undergone structural reconstruction [3-4]. This phenomenon also signifies that urban management is undergoing a fundamental transformation from "digitalization" to "intelligentization." As this transformation progresses, smart cities, as an advanced form of informatized urban development, have gradually become an important vehicle for promoting the upgrading of urban governance systems and the optimization of spatial structures[5]. From an international perspective, the integration of AI and cities is no longer a regional topic; cities worldwide are exploring pathways for AI-empowered governance, and research over the past five decades has undergone a profound shift from a technology-oriented to a governance-oriented approach [6-7]. Within the smart city framework, the application scenarios, barriers, and future directions of AI technology have also become a subject of sustained scholarly attention [8].

In October 2025, the Ministry of Housing and Urban-Rural Development and eight other departments jointly issued an action plan (2025–2027), marking the entry of AI-empowered urban governance into an institutionalized and systematic advancement phase.

While AI endows cities with "intelligence," it also creates governance dilemmas. Algorithmic black boxes make decision-making processes difficult to trace for accountability; data bias may solidify or even amplify social inequality; and privacy leakage risks persist. How to curb the negative effects while leveraging the advantages of technology has become a challenge that both theory and practice must confront. Against this backdrop, this paper aims to explore the opportunities and challenges of urban management in the age of AI and to seek feasible pathways for mitigating risks and optimizing governance.

2 THE VALUE MECHANISM OF AI-EMPOWERED URBAN MANAGEMENT

The value of AI for urban management is not limited to any single aspect but constitutes a systemic reshaping of the whole.

2.1 Improving Operational Efficiency

Before the embedding of AI technology, a significant amount of government staff time was consumed by repetitive and procedural tasks, limiting administrative efficiency and incurring high operational costs. Now, generative AI, acting as a

"digital assistant," can reduce the expenditure of human resources on tedious tasks, freeing public officials from repetitive duties and allowing their energy to shift toward work and decisions that require human judgment [1].
Tools like ChatGPT, if deeply applied, can actually help governments compress hierarchies and streamline institutions. With a unified technology platform, many intermediate steps can be bypassed, and efficiency becomes considerably higher than before. The technology platform becomes more concise and efficient, streamlining both vertical management levels and horizontal institutional configurations [1]. The algorithmization of government governance can also flatten administrative hierarchies, quickly coordinate governance resources across levels and departments, and reduce governance costs [9]. In the practice of the Tianjin Eco-City, unified data interfaces and standardized platforms mean that departments no longer need to build their own incompatible systems but share the same infrastructure, gradually achieving "one system, citywide use" . After the embedding of large models in government services, not only have capability boundaries been expanded, but four types of human-AI collaborative government service models have begun to take shape, and interdepartmental coordination efficiency has noticeably improved [3].

2.2 Scientific Decision-Making

In the past, collecting, organizing, and analyzing information was both time-consuming and labor-intensive. With limited data sources, decisions inevitably carried bias and uncertainty. AI, with its data processing and pattern recognition capabilities, is changing this situation.
The AI-driven predictive governance model integrates multi-source data such as traffic cameras, environmental sensors, and government databases to analyze in real time and identify potential urban problems in advance. In traffic management, the "traffic congestion relief large model" system deployed by Shanghai police automatically optimizes signal timing plans through real-time analysis of road network data. By the end of 2025, the system had been deployed at 360 intersections citywide, with average vehicle speeds at pilot intersections increasing by 12.9% and congestion warning response times reduced from 5–10 minutes to 5–10 seconds [5]. The shift from reactive response to proactive anticipation is not merely a technological upgrade but signifies a fundamental change in the urban governance paradigm.
The broadening of the information base and the optimization of decision-making procedures directly contribute to improved decision quality. ChatGPT-like tools can not only provide more comprehensive information support but also generate different options based on actual conditions, helping to reduce the bias introduced by empiricism and subjective judgment [1]. In the practice of Hangzhou's City Brain, after the introduction of AI, data between departments was no longer mutually blocked, communication costs dropped significantly, and decision-making gradually shifted from relying on experience to becoming more scientific . The rise of technology governance models such as the City Brain has also given birth to "the birth of perceptual politics", governance in the era of human-machine collective intelligence is no longer a simple application of technological tools but a new form in which perception, data, and decision-making are deeply coupled [10].

2.3 Precision and Equalization of Public Services

People-centered urban governance requires that public services not only respond to diverse needs but also cover every resident. AI technology offers new possibilities for achieving this goal.
At the precision level, AI-driven government service systems can leverage user profiling and behavioral data to provide personalized recommendations and intelligent Q&A. Large model-driven systems can identify problem types in real time and generate corresponding solutions. This "perception–cognition–disposition–decision" closed loop helps drive urban governance from experience-driven to data-intelligence-driven, improving the precision and responsiveness of public services [11]. Smart city construction also has a positive impact on residents' well-being. Empirical analysis has found that smart city construction can increase residents' happiness by approximately 4.1%, largely because residents become more familiar with internet services and e-government levels improve [12]. From an international perspective, AI applications in smart cities span transportation, energy, environment, public safety, and other domains, showing significant potential in improving service precision [8].
At the equalization level, platform-driven digital government can break down "information silos" and "data barriers," enabling data sharing and platform integration to extend quality service resources to grassroots levels, narrowing urban-rural and regional gaps, and providing an architectural foundation for cross-departmental collaboration, thereby enhancing governance effectiveness .

2.4 Enhancing Urban Resilience

Deeply embedding AI technology into urban operations can improve a city's adaptability and recovery capacity in complex risk environments.
When dealing with urban waterlogging, integrating multi-source data such as IoT sensors and satellite imagery, combined with AI-driven data visualization technology, can yield more precise disaster impact predictions and better resource allocation plans, making disaster response more agile and accurate[5]. Moreover, the "urban smart brain" of the Sino-Singapore Tianjin Eco-City has connected 40 business systems across 17 departments, deployed over 4,000 intelligent cameras, and integrated drone patrols and voice service platforms, forming a closed-loop capability of "citywide perception, intelligent analysis, and emergency dispatch" . This case also demonstrates that AI is not merely a technological tool but can drive urban operations from fragmented silos toward holistic coordination.

As editorial perspectives on AI and the city have emphasized, the intelligent transformation of urban governance requires not only technological deployment but also institutional adaptation and the building of collaborative frameworks across government departments [6]. Urban resilience is not only about technological disaster resistance but also about the governance system's ability to adapt and adjust in the face of uncertainty.

2.5 Reducing Administrative Burden

Administrative burden, simply put, refers to the various costs that citizens incur when interacting with the government, such as learning costs, compliance costs, and psychological costs. Excessive administrative burden not only reduces public satisfaction but may also exclude vulnerable groups who genuinely need services.

The application of AI offers new approaches to reducing administrative burden. Technologies like ChatGPT, with strong search and data processing capabilities, can help the public more easily find, understand, and use government procedures, effectively avoiding the predicament of "no access, no consultation, no communication" [1]. In practice, the "urban smart brain" of the Sino-Singapore Tianjin Eco-City adopted a "toolbox" model, unifying the dispatch of public resources such as drones, intelligent vision, and intelligent voice. When grid workers discover a problem, they connect directly to the platform, and the system automatically assigns tasks. This has significantly reduced the coordination costs of running between departments and accelerated response times .

3 RISKS AND CHALLENGES OF AI IN URBAN MANAGEMENT

While AI releases enormous empowering potential, it is accompanied by risks and challenges that cannot be ignored. These risks are not occasional technical failures but systemic issues deeply intertwined with technological characteristics, institutional environments, and social structures.

3.1 Algorithmic Black Boxes and Data Bias at the Technical Level

The operational logic of AI systems differs markedly from traditional administrative procedures[5]. The difficulty of understanding algorithms stems from two aspects: on one hand, algorithms are technologically complex and involve confidentiality, and most people lack the relevant knowledge to comprehend them; on the other hand, machine learning enables algorithms to update autonomously, further severing human perception of them and making them even harder to understand[9]. The rise of algorithmic governance in public administration, while bringing efficiency gains, has also triggered risks such as power expansion and accountability deficits that require institutional responses[13].

Data bias is another thorny issue. The effectiveness of AI depends largely on the quality of training data. If the data inherently carries historical prejudices or sample imbalances, algorithmic decisions may replicate or even amplify these biases [1]. The algorithmic risks of generative AI also involve computational bias and power relations, and the depletion of training data may lead to model performance degradation[14]. Code is ultimately written by humans, reflecting the subjective choices of designers and developers, and so-called "precise algorithms" cannot fully eliminate human factors [1].

Furthermore, technology dependency risks are equally noteworthy. As AI is deeply embedded in urban management, government entities' dependence on technology grows by the day, potentially leading to technological decisions increasingly replacing human decisions. Enterprises that master core technologies possess technological initiative, creating the risk of profit-driven corporate interests undermining government authority [1]. In the risk architecture of government governance algorithmization, "government technological disadvantage" is also identified as a significant risk — the government is merely a user rather than a designer of AI technology, placing it in a weak position in the technological game .

From an international perspective, the optimization of algorithm-enabled public service provision has become an important topic in digital governance. When algorithms participate in public decision-making, citizens exhibit significant differences in attributing responsibility for "human vs. algorithm" decisions, and this cognitive difference directly affects accountability outcomes [15].

3.2 Privacy Violations and Algorithmic governance at the Ethical Level

AI applications in urban governance involve the collection of large amounts of citizen data, such as location information and behavioral trajectories. Once such data is leaked or abused, personal privacy is seriously compromised.

Algorithmic governance in the algorithmization of government governance is equally concerning. Taking predictive policing as an example, discriminatory practices inherent in training data may lead algorithms to over-monitor certain communities. In areas such as hiring, lending, and welfare distribution, algorithms may also produce discriminatory judgments against specific groups. Such biases are difficult to detect and correct, and may even self-reinforce: biased prediction results become new training data, deepening existing biases and forming a "self-fulfilling prophecy," a situation termed "administrative exclusion" [9]. Training data bias systematically affects algorithmic fairness and is difficult to fully eliminate with existing technology alone, requiring simultaneous intervention at the design, collection, and auditing stages.

The digital divide is another issue that cannot be ignored. The improvement in well-being brought by smart city construction has not been enjoyed by everyone. Research shows that the happiness of those under 60 increased by 3.7%,

while the change for those 60 and above was not statistically significant; the happiness of high-income populations increased by 4.6%, but low-income populations did not significantly benefit [12]. This means that the dividends of technology flow more to younger and higher-income groups, while the elderly and low-income individuals may be left behind by the accelerated construction of smart cities, further exacerbating social stratification. In the discourse on building a digitally inclusive aging society, how to prevent the elderly from being marginalized by technology has become a global challenge [16]. From a broader perspective, AI may even exacerbate spatial inequality on top of the digital divide, forming a kind of "neo-colonial intelligence" — the implicit domination of technologically strong regions over weaker ones [17].

3.3 Accountability Difficulties at the Institutional Level

When algorithmic decisions harm public rights and interests, the current legal framework is not yet sufficiently developed, lacking clear accountability pathways, with ambiguous attribution of rights and responsibilities leading to the formation of an accountability vacuum [5].

The emergence of algorithm-enabled governance means that the algorithmization of government governance involves multiple actors. When an algorithmic decision goes wrong, administrative personnel may shirk responsibility on the grounds that "power has been transferred to the algorithm," creating accountability evasion. More troubling is that the operation of algorithm-enabled governance embeds four layers of principal-agent relationships: political figures and bureaucratic agencies, bureaucrats and external agencies, external agency management and data scientists, and data scientists and algorithms. This means that every link in the accountability chain has reason to pass responsibility to the next, ultimately leading to an accountability vacuum [9,18]. The legal regulation of digital governance in mega-cities is also prominent, with data sharing, algorithmic decision-making, and rights protection all requiring more comprehensive legal frameworks [19].

4 PARADIGM SHIFT: FROM TECHNOLOGY-CENTERED TO PEOPLE-CENTERED

The aforementioned risks and challenges are not simple technical problems; their root cause is an excessive trust in technology. Under this mindset, efficiency becomes the supreme goal, urban management turns into a bookkeeping project, and residents gradually become data points. The result is that efficiency may increase, but social equity, citizens' rights, and government credibility may suffer. Coupled with the assessment pressure and competitive mentality brought by the "intelligentization tournament," local governments are more likely to focus on short-term "innovative achievements" rather than genuinely solving people's practical problems [2]. Research has pointed out that the deep integration of AI and cities, if left unguided, may spawn an "AI urbanism" — under the narrative of "post-smart cities," technological logic overrides social logic, and the public nature of urban governance is eroded [20]. The shift from "intelligentization of social governance" to "governance of the intelligent society" is itself a reflection on the technology-centered paradigm [21].

To escape this predicament, the key is to let "people-centeredness" regain its dominance. This cannot be merely a slogan; it requires a shift in thinking at three levels: first, the object of governance is not a pile of data but people with emotions and dignity; second, humans and technology are not in opposition but should work in concert; third, the pursuit is not only efficiency but also fairness and justice [5]. The fundamental goal of human-AI collaboration in urban social governance lies in the realization of "people-centeredness" — making technology serve people, not the reverse [22]. The following discusses three pathways for promoting this transformation.

4.1 Building a Human-AI Collaborative Mechanism

Generative governance for complex social fields is exploring a new approach — combining the creativity of generative AI with human judgment to seek breakthroughs in governance methods [23]. The case of Tianjin's T Village also reveals an "adaptive survival of power-algorithm" human-AI co-governance mechanism in smart governance of urban villages, where algorithms do not replace human subjectivity but find a balance in the game between power and technology [24]. From an international perspective, the "ensembling" decision-making model has been shown to significantly improve the quality of public administration decisions — the collaboration between AI and public managers is not simple human-machine substitution but complementary advantage [25]. After generative AI large models are embedded in social governance, their empowering scenarios, risk patterns, and regulatory pathways need to be considered holistically, not focusing solely on efficiency while ignoring risks [26].

Human-AI collaboration also provides a way out of the accountability dilemma. Accountability and fault tolerance must be integrated: responsibilities must be clarified while space for innovation is preserved. Higher-level authorities should specify clear assessment indicators, with quantitative indicators aligned to the actual transformation and qualitative indicators avoiding vague language, while establishing collaborative accountability mechanisms for the public and enterprises [2]. It must be emphasized that accountability should run through the entire process of algorithm design, deployment, and operation, not just post-hoc accountability. These ideas are highly consistent with human-AI collaborative design.

4.2 Achieving Inclusive Governance

Algorithmic governance often stems from training data bias or a narrow designer perspective. Citizens, especially vulnerable groups, should be transformed from passive data sources to active participants, with diverse stakeholders introduced for joint supervision at every stage of system design, development, and oversight [27]. In the "normative – value – technology" model, value coordination drives data flow through trust, shared goals, and leadership willingness .
Service thresholds must be lowered. Senior-friendly modes, accessibility features, and public education must all keep pace. Smart cities should meet residents' needs and build a co-constructed and shared public service system; neglecting vulnerable groups only amplifies technological injustice [12]. The construction of a digitally inclusive aging society from a global perspective requires a multi-pronged approach encompassing evolutionary history, issue focus, and pathway exploration, so that the elderly are not left behind in the digital wave [16].
Value coordination is the soft bond of the "normative – value – technology" model, driving data to flow between departments through organizational trust, shared goals, and leadership willingness .

4.3 Building an Agile and Transparent Algorithmic Regulatory System

The algorithmic regulatory framework needs to balance inclusive prudence with classified and tiered approaches. Ethical red lines should be set for AI applications involving citizens' fundamental rights, while preserving space for innovation [5]. The agile governance of government large models requires multi-dimensional consideration based on "data-scenarios," maintaining governance flexibility and adaptability during rapid iteration [28]. Smart governance, as a theoretical construction and practical pathway for the innovation of contemporary Chinese government governance paradigms, has at its core the fusion of technological capability and governance wisdom .
Algorithmic decision-making must shift from "unspeakable" to "explainable." This requires three institutional arrangements: first, algorithmic transparency, meaning the public has the right to know what data was used, what rules were applied, and how results were produced in decisions affecting their rights. Second, explanatory response, meaning that when citizens raise objections to algorithmic decisions, administrative personnel must provide clear explanations and cannot deflect with "the system computed it." Third, correction and remedy, meaning that erroneous algorithmic decisions should be promptly corrected, and clear compensation mechanisms should exist for damages caused [9].
At the same time, algorithmic governance must not remain in the narrow mindset of "let technology solve technology's problems." The public value of digital government depends on the synergy between administrative logic and technological logic, and both scientific-technological ethics review and administrative ethics review must proceed simultaneously [2]. From an international perspective, the harmonization of AI ethical guidelines and legal frameworks is crucial; only when the two form a combined force can governance be effectively implemented [29]. Public trust in government AI applications also depends on the balance of transparency, ethical norms, and actual benefits — without any one of these, trust is difficult to establish. The process by which public organizations implement AI governance requires comprehensive advancement from institutional building and organizational capacity to oversight mechanisms, not merely policy slogans. Local governments at all levels, when formulating responsible AI strategies, also need to draw on international experience and adapt to local conditions.
Governments at all levels are the responsible entities, but ethics committees cannot be composed solely of internal personnel; they need to absorb external technical experts and public representatives. The review process should establish a complete "application – assessment – resolution – supervision" workflow covering the entire algorithm lifecycle. As for review content, it should address both technical risks such as data quality, model bias, and security protection, as well as the impact of AI on the governmental activities themselves. Moreover, technological means alone cannot solve the problem of algorithmic fairness; a multi-stakeholder ethical oversight mechanism is also needed. The legal regulation of digital governance in mega-cities also needs to establish systematic institutional arrangements from a public law perspective in areas such as data sharing, algorithmic decision-making, and rights protection [19].

5 CONCLUSION AND IMPLICATIONS

The application of AI in urban management has both improved governance efficiency, reduced administrative burden, and enhanced urban resilience, and brought risks such as data privacy, algorithmic governance, and accountability ambiguity. The root cause lies in blind pursuit of technology and short-term behavior under competitive pressure. The solution is to shift toward people-centeredness, and within the framework of human-AI collaboration and inclusive governance, not sacrifice equity for efficiency.
Four policy implications emerge:
First, avoid blind worship of technology. While paying attention to efficiency gains, be vigilant about potential risks. Establishing a "scenario – need – effect" evaluation mechanism helps prevent the formalization tendency of technological innovation.
Second, accelerate the construction of institutional frameworks. In management, clarify the rights and responsibilities at each stage of algorithm deployment; in law, build transparency, explanation, and remedy systems; in ethics, promote coordinated review of scientific-technological ethics and administrative ethics. The harmonization of AI ethical guidelines and legal frameworks is also key, and the transparency, ethics, and benefits of government AI applications are all indispensable.
Third, give more consideration to vulnerable groups. The dividends of smart cities currently flow more to high-income and younger groups, with the elderly and low-income populations benefiting less noticeably. Senior-friendly design,

accessibility features, and public education should be pursued simultaneously. Fairness should be considered across the entire chain of data collection, algorithm design, and result distribution.

Fourth, strengthen personnel training so that they can identify algorithmic bias, assess risks, and dare to intervene with human judgment at critical moments. The human-AI ensembling decision-making model demonstrates that the collaborative effect of AI and public managers is far superior to either party acting alone. Technology and talent must develop together to better build smart cities.

The deep integration of AI and urban management is an inevitable trend. However, the core remains putting people first, letting technology and institutions advance together. In this way, cities can become not only smarter but also warmer.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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