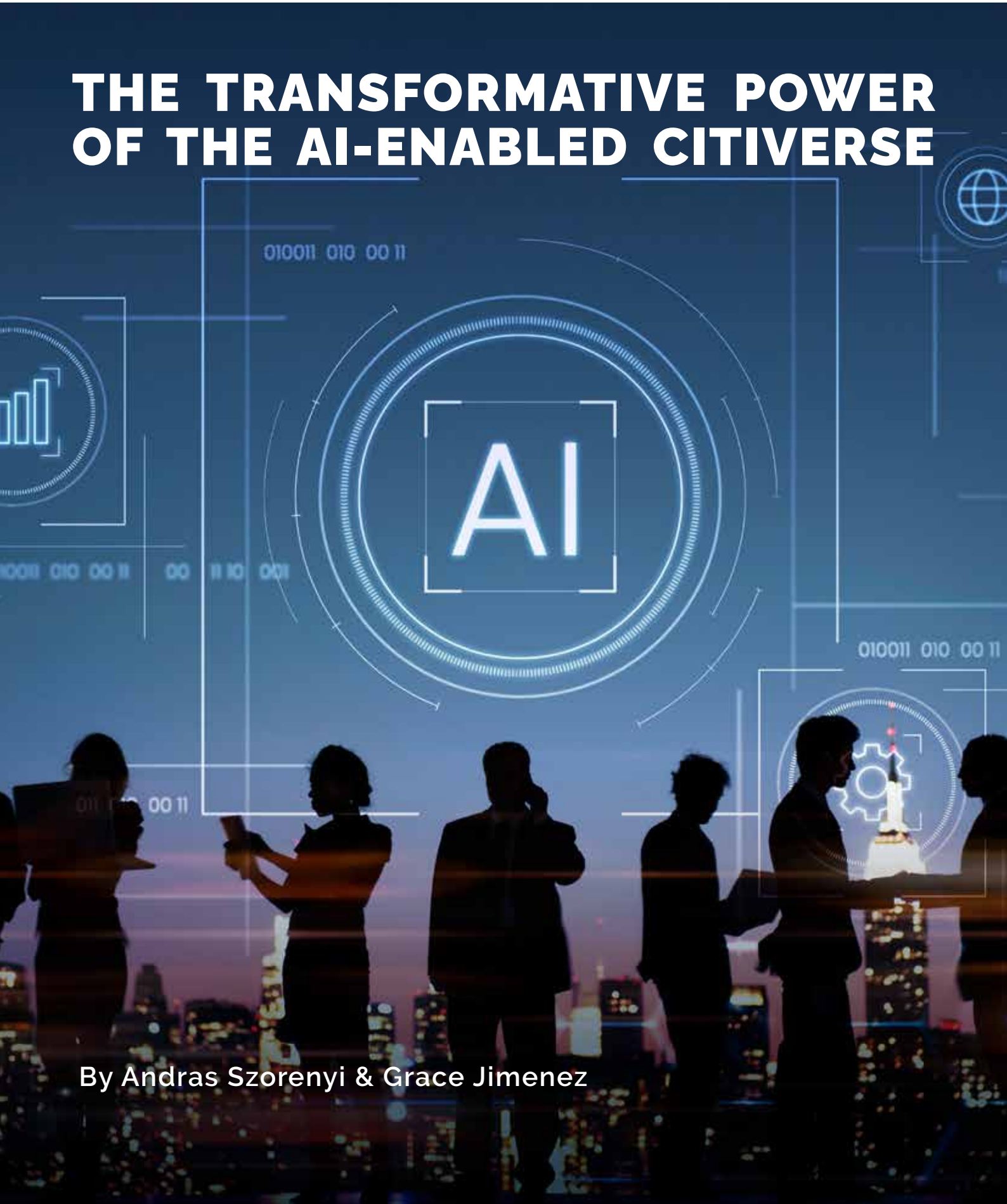
June 2026

GLOBAL CITIES HUB
— GENEVA

THE TRANSFORMATIVE POWER OF THE AI-ENABLED CITIVERSE



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Executive summary

Artificial intelligence (AI), digital twins, immersive technologies, and data-driven systems are transforming cities and shaping the emerging "citiverse" — a connected digital ecosystem where physical and virtual urban environments interact. While the citiverse is often referred to as an evolution of existing smart city practices already being used in areas such as mobility management, energy systems, and public services, this paper argues that the AI-enabled citiverse should be understood as a **governance transformation challenge** that will influence how cities plan, deliver services, interact with citizens, and respond to crises.

AI can help local and regional governments (LRGs) improve efficiency, sustainability, resilience, and citizen participation through tools such as predictive analytics, intelligent infrastructure management, digital twins, and conversational public services.

The benefits of AI are not automatic: without appropriate governance frameworks, AI systems may reinforce inequalities, increase dependence on large technology providers, create privacy and cybersecurity risks, or exclude communities lacking digital access and skills. The impacts of AI may also differ significantly between municipalities depending on their size, institutional capacity, infrastructure, and socio-economic realities.

To address these challenges, the paper emphasizes the importance of people-centered and inclusive governance approaches. It calls for transparency, accountability, citizen participation, and readiness-based implementation pathways adapted to local contexts. It also highlights the role of standard development by international organizations and multilateral cooperation in supporting cities through this digital transformation.

Other associated planetary challenges, such as water and energy use of data centers, risk of widening AI-divide between and within societies, etc. are not ignored but left aside to keep the length of the paper reasonable.

Ultimately, the success of the AI-enabled citiverse will depend not only on technological innovation, but on the **ability of cities to govern these technologies** in ways that strengthen public trust, improve quality of life, and support sustainable and inclusive urban development. To help readers understand the opportunities and risks brought by the deployment of AI-enabled technologies, the paper offers useful sources, directly applicable tools, and recommendations for further consideration.

1. From smart cities to the citiverse

Reflecting a socio-economic shift

Cities around the world are navigating an intense shift toward integrating advanced virtual representations — often described as digital twins or immersive urban environments — to enhance planning, municipalities' predictive capabilities, and citizen engagement. This immersive digital environment is transforming how people live, learn, govern, and interact. The **transition to a "citiverse"** — understood as a connected ecosystem combining physical cities with virtual interaction spaces for governance, services, and civic participation — is a generational project. Success is measured by improving the lives of people, and building a more resilient, sustainable, and inclusive urban future.

Many cities are already using early forms of AI in areas such as traffic management, online public services, energy monitoring, and emergency response systems. While early smart city initiatives focused on sensors and data dashboards, the newly emerging paradigm of the **citiverse represents a city-scale digital ecosystem** that integrates physical infrastructure, digital twins, immersive technologies, and AI-driven decision-making systems. It is an evolving set of digital tools built on data systems that cities may adopt progressively according to their needs, priorities, and capacities.

Artificial intelligence is increasingly recognized not simply as another digital tool, but as a foundational general-purpose technology — similar in transformative impact to electricity, the steam engine, or the internet. In socio-economic terms, an AI-enabled citiverse will eventually reshape productivity, labor markets, economic structures, and governance systems at all levels across nearly every sector of society. Sooner or later, all cities will face the deployment of the citiverse at different levels, and their leaders' choice will not be 'if' but 'how' they can use it for the benefit of the population.

Organizations optimize processes, reduce inefficiencies, and develop new products and services with AI, while entire industries are being reshaped through applications such as predictive maintenance, precision agriculture, automated financial analysis, personalized healthcare diagnostics, and adaptive learning systems. Local and regional governments (LRGs) that successfully build AI capabilities and optimize their processes are also likely to gain significant competitive advantages.

How AI supports urban decision-making

Unlike earlier waves of automation that primarily mechanized physical tasks, AI enables the automation and augmentation of cognitive work. Machine learning systems can process vast amounts of data, identify complex patterns, generate insights, and support decision-making in domains previously dependent on human expertise, such as local public administration. However, their impact depends heavily on governance choices, institutional capacity, data quality, and the social contexts in which they are deployed.

AI, IoT, digital twins, and spatial intelligence applications can help with forecasting housing demand, optimizing energy systems, and strengthening climate resilience. Although the use of AI will not reduce the complexity of socio-economic decision making, it can provide predictive simulations and speed up implementation, enabling paradigm change. Meanwhile, leaders at all levels need to be aware that some implications of AI-enabled technologies might also generate new challenges for our societies. To anticipate these challenges, cities should move the narrative from the digital gap between countries and communities to digital dignity, focusing on skills, standards, and solutions.

From a broader societal perspective, **AI is likely to reshape how humans interact with technology and information**. Intelligent digital assistants, automated decision-support systems, and generative AI tools are already changing how people work, learn, and communicate. Citizens might soon expect similar consumer experiences from municipal service providers. These tools enhance human capabilities, but they also raise questions about trust, accountability, and the role of human judgment in automated systems.

When integrated thoughtfully into urban systems and broader economic structures, artificial intelligence will be determinant in the 21st-century socio-economic transformation, supporting smarter cities, more resilient economies, and more responsive public institutions. Due to its transformational nature its adoption will be a must rather than an option.

Current trends

The five trends shaping the next era of use of AI technology in cities, as presented at the 3rd UN Virtual Worlds Day, might enable the move from idea to pilot and to impact much more quickly, therefore can accelerate the development of digital city ecosystems based on the AI-enabled citiverse:

1. World Models: a city-scale simulation of traffic, economy, infrastructure, and even citizen behavior, before actions are taken. This allows for testing the impacts of decisions in advance.

2. Agentic AI: autonomous decision systems, which can plan, reason, and execute tasks independently across workflows and systems. This permits goal-driven autonomy.

3. Physical / Embodied AI: autonomous operations of robots, drones, and intelligent machines in the physical world in a safe and efficient manner.

4. AI-native Virtual Worlds: living civic environments, where citizens and systems can interact persistently. These allow for immersive, interactive experiences and engagement.

5. Digital twins + Immersive collaboration: real-time control systems that can integrate IoT and AI predictions into real-time optimization of digital replicas and real-world operation of city systems.

2. AI-enabled urban governance

Adaptation of local public sector

In the public sector, AI offers governments new tools to design policies, allocate resources more effectively, and anticipate societal challenges. For cities and municipalities, this translates into more responsive governance, where services are optimized based on real-time needs and policy interventions can be tested in simulation environments before implementation. Artificial intelligence transforms raw urban data into actionable insights. AI systems can detect patterns in traffic flows, energy consumption, water systems, waste management, and public safety. Combined with **digital twins of cities**, municipal authorities can simulate scenarios, anticipate disruptions, and plan interventions before problems occur.

Beyond operational improvements, AI is changing how cities make decisions. Urban leaders increasingly rely on **data-driven governance**. An AI-enabled citiverse is only as good as the data it processes. Therefore, prioritizing data infrastructure before AI applications is key. Investing in data integration and developing open data lakes yield long-term returns across all subsequent applications.

Digital twins allow planners to evaluate urban development scenarios — such as zoning changes, infrastructure investments, or climate adaptation strategies — and their potential impact on citizens. For cities facing rapid urbanization, climate pressures, and fiscal constraints, AI-enabled municipal services offer the potential to dramatically **improve efficiency, resilience, and quality of life**. The citiverse also represents a citizen participatory urban platform, where citizens and systems can interact persistently — enabling citizens to join urban simulations, visualize policy impacts, and contribute to planning processes.

However, this transformation requires strong governance frameworks to ensure **transparency, accountability, and ethical use of AI** in public administration. AI systems can reproduce or amplify existing biases present in data, potentially leading to unfair outcomes in areas such as hiring, lending, policing, or access to services. Ensuring fairness, accountability, and human oversight in AI systems is therefore a critical component of responsible deployment.

At the core of the citiverse lies the fusion of three capabilities:

1. Real-time data infrastructure
2. AI and machine learning analytics
3. Digital twins and immersive interfaces

AI Agents for core municipal services

In the citiverse, municipal services are not only digitized but also become **adaptive, predictive, and citizen-centric**. Artificial intelligence acts as the operational intelligence layer that processes real-time data, anticipates needs, optimizes services, and supports more responsive governance. City administrators, citizens, and businesses can interact with these systems through **interactive dashboards, augmented reality, and simulation environments**.

Urban Mobility

AI enables dynamic traffic management, predictive maintenance of public transport infrastructure, and optimized routing for buses and emergency services. Machine learning can process traffic sensors, GPS data, and historical patterns to reduce congestion and improve mobility efficiency. AI also supports the transition to **autonomous and shared mobility systems**.

EMT Madrid has introduced AI-supported mobility management tools integrating real-time transport data to improve operational efficiency, multimodal mobility planning, and user experience across the city's public transport system.

Energy and Utilities

Cities are major energy consumers. AI can **optimize smart grids**, manage distributed renewable energy, and forecast consumption patterns. This helps municipalities reduce costs, lower emissions, and increase resilience to disruptions. In water systems, AI-based monitoring can detect leaks, predict pipe failures, and improve water quality management.

Kigali's Smart City initiative, developed under Rwanda's Smart City Master Plan, integrates IoT systems, digital infrastructure, and data-driven urban management tools to improve energy efficiency, environmental monitoring, and public service delivery.

Waste and Circular Economy

AI can transform waste management through **smart collection routes, automated sorting technologies, and predictive demand modeling**. This reduces operational costs while increasing recycling and resource recovery. AI-powered analytics also enable cities to track material flows and develop circular economy strategies.

The National Environment Agency in Singapore introduced a public waste collection contract requiring the use of fully dynamic route planning software to optimize daily refuse and recyclables collection, supporting more responsive urban waste management.

Public safety and Emergency management

AI enhances situational awareness through **real-time data fusion** from cameras, sensors, and emergency communication systems. Predictive models can identify areas of risk, support disaster preparedness, and optimize emergency response times. AI-supported digital twins allow authorities to simulate evacuation routes and response strategies during floods, pandemics, or extreme weather events.

The Digital Twin of the Port de Bordeaux integrates real-time environmental, hydrological, and infrastructure data to simulate flood risks, monitor river conditions, and support disaster preparedness and crisis-response in the context of climate-related hazards.

Citizen engagement and Service delivery

Conversational AI systems and intelligent digital assistants can **simplify citizen interactions** with government services. Residents can access permits, report issues, or obtain information through natural-language interfaces. AI can also analyze citizen feedback, social media signals, and service data to identify unmet needs and improve service design.

Buenos Aires developed "Boti," an AI-enabled chatbot initially launched to support COVID-19 vaccination services and later expanded to provide residents with information on healthcare and other public services such as bike sharing, mobility, and social care through natural-language interactions.

3. AI Wild West

AI potential for public good...

AI-enabled technologies, including virtual worlds, have **great potential to deliver public goods**. AI can dramatically expand access to, and quality of, health care services. Beyond diagnostics, AI copilots can help make decent care available to millions more people at lower cost. Education could become genuinely personalized. Instead of one-size-fits-all classrooms, AI tutors can adapt to each student's pace, gaps, and learning style. Done well, this could reduce inequality. Scientific discovery could accelerate dramatically. Breakthroughs in energy, medicine, or agriculture cascade into public good indirectly but powerfully.

Public services and governance can become more responsive. AI can help with fraud detection, traffic optimization, emergency response, and policy simulation. To build truly people-centered cities and communities, innovation must be guided to create tangible public value, improve quality of life, reduce inequalities, and nurture nature.

...or socially bad and economically ugly

However, **the socio-economic transformation driven by AI also raises significant challenges**, among others in the future of work and urban development.

Drawing on historical patterns and existing datasets, AI models can unintentionally reproduce or amplify structural inequalities already present in urban systems, particularly in areas such as policing, infrastructure investment, or access to public services. For instance, in large metropolitan areas with historically rooted patterns of socio-economic discrimination, biased datasets may lead AI-enabled systems to deprioritize or inadequately serve already marginalized neighborhoods.

The **risks and implications of AI deployment** may also vary significantly depending on the scale, institutional maturity, and socio-economic context of municipalities. While large cities may face challenges linked to data bias and job market disruption due to AI systems automating many cognitive tasks, smaller municipalities may encounter vendor lock-in. In newly established municipalities or territories shaped by informal settlements, social dynamics and urban realities are often insufficiently documented or difficult to model through AI systems, which may increase the risk of inaccurate predictions.

AI development also requires large datasets, computational resources, and specialized expertise, which can favor large technology firms and advanced economies. Without appropriate governance mechanisms, this concentration could widen economic inequalities between companies, regions, and countries — creating a new virtual wild west.

Opportunities

- **Improved efficiency of municipal services** through automation and predictive analytics
- **Cost savings** in infrastructure maintenance and service delivery
- **Better urban planning** through digital twins and simulation tools
- **Enhanced sustainability,** including optimized energy use and reduced emissions
- **More responsive governance** through real-time data and citizen feedback
- **Improved mobility systems** and reduced congestion
- Stronger resilience to climate events and urban disruptions
- **Personalized citizen services** and simplified access to public services
- **Data-driven policy design** and evidence-based decision-making

Challenges

- **Data governance and privacy** concerns related to large-scale urban data collection
- **Vendor lock-in** leading to economic dependence from one provider
- **Cybersecurity risks** for critical city infrastructure
- **Algorithmic bias** in AI-driven decision-making systems
- **Digital divide** excluding certain populations from AI-enabled services
- **High upfront investment** in digital infrastructure and platforms
- **Need for new skills** in municipal administration: data science, AI governance, etc.
- **Public trust and transparency** in automated decision-making

4. Tools and sources

Where should LRGs start to build a citiverse? They might have different characteristics (size, population, geography, history, GDP, etc.) and their aims concerning local development might vary significantly. Once the vision is formulated and the goals are clarified, three core principles guide the evaluation of the readiness of an LRG to implement the citiverse:

- Readiness over Eagerness: The position of a city is determined by its current, verified capabilities and established infrastructures, not its future ambitions. Value is placed on an honest assessment of the existing foundation.

- Local Context Defines the Pathway: The evaluation framework is neutral; a city, or a local or regional governments' unique needs, priorities and existing capacities are what interpret the results and shape the subsequent implementation roadmap.

- Managed Progression from Simple to Comprehensive: The structure inherently encourages building confidence by validating capabilities before advancing to initiatives that require more integrated systems.

The various guidelines, principles, and toolkits developed or under development by relevant international organizations serve as frameworks for creating people-centered citiverses, ensuring that digital urban infrastructures and data make cities and human settlements more sustainable, inclusive, prosperous, and respectful of human rights. They also play a key role in developing local AI ecosystems for businesses and making sure that new technologies are used efficiently and ethically. Below are some possible starting points:

ITU's "Executive Briefing on AI, Spatial Intelligence and the AI-Enabled Citiverse" is designed for decision-makers who must navigate the convergence of AI, spatial intelligence and immersive environments at policy level. It is primarily a strategic framing document, contextualizing AI, spatial intelligence and the citiverse within global governance frameworks.

ITU's "City Leader's Field Guide: Preparing for the AI-enabled citiverse" provides a comprehensive assessment tool for leaders of cities to evaluate their readiness for citiverse implementation. The tool covers 14 key domains with 172 indicators across critical capacity areas. It offers a modular pathway that any local and regional government can adopt regardless of size, resources or current maturity.

UNITAC's (UN-Habitat) "Digital Tools for Sustainable Urban Futures" deploy people-centered technologies such as AI mapping, mobile and USSD apps, participatory platforms, geospatial visualizers, and open data tools to deliver inclusive and scalable urban solutions to real world problems.

5. Multilateral platforms to consider

The development of the above-mentioned tools and other policy discussions takes place in several multilateral platforms. The 'AI Governance Beyond 2025: UN Pathways and Implications' research states that "While all the experts brought a unique institutional view, a general agreement was on the observation that the UN functions more as a convener and a facilitator of dialogues than as a regulator. The current institutional set-up is defined by fragmented initiatives led by various UN agencies, i.e. ITU, UNESCO, UNDP, UNCTAD, ILO, and the ODET." Here is a non-exhaustive list of organizations, agreements, initiatives, and platforms where LRGs and international organizations might engage in a mutually fruitful way. GCH encourages LRGs to actively participate in and contribute to these processes by sharing their own experiences.

United Nations General Assembly

The Global Digital Compact (GDC) is a UN-adopted framework designed to govern digital technologies and artificial intelligence. It serves as a roadmap for international cooperation to close digital divides, ensure safety online, and uphold human rights, functioning as part of the Pact for the Future.

Mayors for Digital Cooperation (MDC) brings together mayors from around the world to collaborate on the effective use of digital technologies and localize the Global Digital Compact to advance the Sustainable Development Goals and improve urban governance.

International Telecommunication Union (ITU)

The AI for Good summit connects governments, researchers, and companies to apply AI to social challenges (health, climate, cities). It emphasizes inclusive, human-centered digital ecosystems which are key to the citiverse.

The UN Virtual Worlds Day showcases how the convergence of AI, immersive virtual environments, spatial intelligence, and other frontier technologies is reshaping urban governance and enabling new approaches to delivering public services in the citiverse.

U4SSC's 'Thematic Group on AI in Cities' explores how agentic AI systems, capable of autonomous interaction and adaptive decision-making, can support city management, sustainability goals, and citizen engagement in an ethical and transparent manner.

The Global Initiative on AI and Virtual Worlds brings together governments, industry, academia, and international organizations to advance dialogue on trustworthy, interoperable, and people-centered virtual worlds and AI-enabled citiverse ecosystems.

The "Call to Action for Humanity: Shaping the Future of Cities in the Age of AI and Citiverse" identifies five strategic priorities: (1) Delivering global commitments locally; (2) Building trusted and inclusive AI systems; (3) Improving decision-making through

data and simulation; (4) Enabling responsible economic and social growth; (5) Strengthening international cooperation and standards.

UN-Habitat

The People Centred-Smart Cities program ensures that deployment of technology and innovation is used to safeguard sustainability, inclusivity, prosperity and human rights in cities.

UNITAC-Hamburg supports national and local governments with their digital transition, applying a multi-level governance strategy and helping them build skills and capabilities to develop, procure and effectively use digital technologies in an ethical and inclusive way.

European Union

The EU's landmark AI Act introduces risk-based regulation. It aims to ensure trustworthy AI in public and private digital spaces. Its work on the citiverse focuses on interoperability, digital identity, and public services in immersive environments.

Council of Europe

Its Framework Convention on AI is the first legally binding international treaty on AI, focused on human rights, democracy, and rule of law (not yet in force at the moment of publishing). It applies to both public and private AI systems, therefore, it de facto covers the development of the citiverse.

6. Open questions and recommendations

Some open questions for consideration

- **How do we align AI systems with human goals and values?** — Ensuring that AI reliably follows human values across cultures and contexts remains a challenge, closely tied to data reliability, safety, evaluation, and control methods.

- **Is it possible to regulate AI in the citiverse without stifling innovation?** — There is no consensus on the right balance between regulation to address risks like bias, job disruption, and market concentration, and flexibility to foster innovation and competitiveness.

- **Can open-source technology build public trust in a virtual world?** — When code, models, or datasets are open, anyone can examine how a system works. Open systems can be tested, challenged, and improved by a community, which might enhance public trust.

- **What is the adequate data governance model?** — As AI systems rely heavily on data, societies must develop clear frameworks for privacy protection, data ownership, and secure data sharing for innovation — particularly in healthcare, public administration, and urban planning.

Recommendations to avoid repeating mistakes in the citiverse

1. **Put citizens at the center:** citizens should have opportunities to contribute to discussions on the deployment of AI systems in public services. They should retain control over how their personal data is collected, shared, and used.

    a. Build co-creation platforms
    b. Enable participatory governance models
    c. Develop digital identity with user control

2. **Build trust by design:** LRGs should ensure that city leaders, municipal staff, and citizens understand how automated systems influence public decisions, resource allocation, or access to services. Their governance frameworks should include safeguards against discrimination, and bias.

    a. Make sure AI systems are transparent
    b. Ensure ethical data governance
    c. Apply privacy-preserving technologies

3. **Embrace balanced decentralization:** avoid excessive concentration of technological control, data ownership, or decision-making power. Over-centralized systems may create vulnerabilities related to vendor lock-in and cybersecurity, while fragmented systems can reduce interoperability and efficiency.

    a. Avoid over-dependance on one service provider
    b. Prioritize data infrastructure before AI applications
    c. Balance innovation with accountability

4. **Focus on meaningful experiences:** the citiverse should not be designed solely around opera-

tional efficiency or technological performance. Urban digital environments must enhance quality of life, social cohesion, cultural participation, and human well-being.

a. Not just efficiency, but quality of life
b. Culture, creativity, and social interaction matter

5. **Ensure inclusivity:** strategies to develop an inclusive citiverse should prioritize universal accessibility, affordable participation, and the active inclusion of historically marginalized or underrepresented communities.

a. Bridge digital divides
b. Accessible interfaces (not just VR/AR elites)
c. Multilingual, affordable participation

6. **Design for resilience, not optimization:** strengthen urban resilience by supporting adaptability, crisis response, and long-term continuity of public services under uncertain conditions, such as climate change, public health emergencies, cyberattacks, migration pressures, and economic instability.

a. Smart cities optimized for "normal conditions"
b. The citiverse should handle uncertainty, crises, and change

Conclusion

If implemented responsibly, AI-powered municipal services can significantly improve urban livability, sustainability, and resilience. However, the success of this transformation will depend not only on technology, but also on **strong governance, ethical safeguards, and inclusive digital strategies** that ensure the benefits of the people-centered citiverse are shared by all citizens.

AI in the citiverse should be understood as an **enabling infrastructure for future-oriented governance** — a technology that amplifies human intelligence and transforms how societies organize cohabitation, production, innovation, and governance. For policymakers and city leaders alike, the challenge is two-fold: adopting an AI-enabled citiverse to enhance municipal services and urban development, and ensuring that AI-based technologies are deployed in ways that promote inclusive growth, democratic governance, and sustainable development. Ultimately, the future of the citiverse will be determined by the capacity of cities and communities to use and govern these technologies in ways that strengthen their socio-economic development in an inclusive, resilient, and sustainable manner.

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