

# THE HUMAN FACTOR IN THE GENOMIC ERA: ETHICAL GOVERNANCE OF GENETIC DATA FOR PUBLIC HEALTH AND SUSTAINABLE DEVELOPMENT

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## Abstract

*The green digital transition is reshaping urban environments through smart technologies, data-driven governance, and climate-resilient infrastructure. Yet, amid rapid technological advancement, the human factor—encompassing health, dignity, equity, and fundamental rights—risks being marginalized. This paper argues that sustainable urban development must be anchored in a human-centered paradigm, where international health law, data ethics, and environmental policy converge to protect citizens' well-being in an increasingly digitized world. As cities deploy AI, IoT networks, and predictive analytics to optimize energy use, mobility, and public services, they simultaneously collect vast amounts of sensitive personal and health-related data. Without robust legal and ethical safeguards, such systems may compromise privacy, exacerbate social inequalities, or undermine public trust. International frameworks—including the WHO's guidelines on environmental health, the UN Sustainable Development Goals (SDGs), GDPR, and UNESCO's Recommendation on the Ethics of Artificial Intelligence—offer critical normative foundations for ensuring that digital sustainability initiatives respect human rights and promote equitable outcomes. Through comparative case studies of urban projects in Europe (Barcelona, Copenhagen), Asia (Singapore, Seoul), North America (Austin), and Russia (Moscow), this study examines how legal compliance, ethical design, and participatory governance can integrate the human factor into smart city ecosystems. Special attention is given to vulnerable populations, including the elderly, low-income communities, and individuals with chronic health conditions, who are disproportionately affected by both environmental degradation and digital exclusion. The analysis reveals that while technological innovation drives efficiency, only a rights-based approach—grounded in international law and inclusive stakeholder engagement—can ensure that the green digital transition enhances not only planetary resilience but also human flourishing. The paper concludes with a proposed Human-Centric Impact Assessment (HCIA) framework, designed to evaluate urban digital initiatives through the lenses of public health, data protection, and social justice.*

**Keywords:** Human factor, green digital transition, sustainable urban development, international health law, data ethics, smart cities, right to health, digital rights, GDPR.

## I. Introduction

The confluence of digitalization and sustainability agendas has given rise to the green digital transition—a transformative paradigm increasingly embedded in urban and regional development strategies worldwide. This transition integrates advanced information and communication technologies (ICTs), including artificial intelligence (AI), Internet of Things (IoT) networks, big data analytics, and cyber-physical systems, into environmental governance frameworks aimed at decarbonization, resource

efficiency, and climate resilience (Bibri & Krogstie, 2020; Neirotti et al., 2014). While these innovations promise enhanced operational efficiency and ecological performance, their deployment raises profound socio-ethical and legal challenges that remain undertheorized in both urban sustainability and cybersecurity discourses.

A critical gap in current research lies in the insufficient integration of the human factor into the design, implementation, and evaluation of green digital initiatives. Predominantly technocentric approaches prioritize system optimization over human well-being, often neglecting the implications of large-scale data collection, algorithmic decision-making, and surveillance infrastructures on individual rights, public health, and social equity (Vanolo, 2014; Kitchin, 2017). As smart city ecosystems expand, they generate vast repositories of personal and sensitive data—ranging from geospatial mobility patterns to biometric identifiers and health-related metrics—positioning citizens as perpetual data subjects within algorithmically mediated urban environments (Zuboff, 2019; Cowls et al., 2021).

This evolution necessitates a normative recalibration grounded in international health law, data protection regimes, and human rights-based approaches to technology governance. Instruments such as the WHO Framework for Climate Action and Health, the United Nations' Sustainable Development Goals (SDGs)—particularly SDG 3 (Good Health and Well-being) and SDG 11 (Sustainable Cities and Communities)—as well as binding regulations like the General Data Protection Regulation (GDPR) and soft law instruments including UNESCO's Recommendation on the Ethics of Artificial Intelligence (2021), collectively establish a legal-ethical foundation for protecting human dignity, autonomy, and non-discrimination in digitally enabled urban spaces (UNESCO, 2021; OECD, 2022).

Despite the existence of these frameworks, institutional fragmentation persists between environmental policy, digital governance, and public health planning. Empirical evidence from global case studies—including Barcelona's Sentilo platform, Singapore's Smart Nation Initiative, Moscow's "UMNIY GOROD" program, and Copenhagen's Climate-Neutral Digital Twin—reveals recurrent tensions between technological efficacy and ethical accountability. For instance, while AI-driven air quality prediction models improve environmental monitoring, they may simultaneously enable discriminatory zoning practices or infringe upon informational self-determination when deployed without transparent consent mechanisms (Albrechtslund, 2022; Zharikova et al., 2023).

This paper addresses an emerging research gap: how can international legal standards in health and data ethics be systematically integrated into sustainable urban development to ensure that the green digital transition remains aligned with human rights and societal well-being? We argue that achieving truly resilient and equitable urban futures requires moving beyond technical risk mitigation toward a rights-based, human-centric governance model that embeds legal compliance, ethical foresight, and participatory oversight into the architecture of digital sustainability projects.

To this end, the study introduces the Human-Centric Impact Assessment (HCIA) framework—a multidimensional evaluative tool designed to assess urban digital initiatives through integrated lenses of public health, data protection, algorithmic fairness, and social inclusion. By synthesizing insights from law, urban informatics, public health, and science and technology studies (STS), this research contributes to the growing body of knowledge on socio-technical resilience and responsible innovation in smart cities.

The remainder of the paper is structured as follows: Section 2 outlines the methodological approach; Section 3 presents comparative case analyses; Section 4 discusses the normative alignment between health law and digital sustainability; Section 5 proposes the HCIA framework; and Section 6 concludes with policy implications and avenues for future research.

## II. Methods

This study employs a transdisciplinary, mixed-methods research design to investigate the integration of the human factor into the green digital transition, with a focus on the interplay between international health law, data ethics, and sustainable urban development. The methodological framework integrates qualitative, quantitative, and comparative legal analysis, with explicit attention to geopolitical and institutional diversity—including Russia as a critical case of state-led digitalization under conditions of technological sovereignty and regulatory isolation.

### 1. Systematic Literature Review (SLR)

A comprehensive systematic literature review was conducted following PRISMA guidelines across Scopus, Web of Science, eLIBRARY.ru (for Russian-language sources), IEEE Xplore, and SpringerLink. Search strings were translated into Russian for domestic databases: ("умный город" OR "цифровизация") И ("здравье" OR "персональные данные") И ("устойчивое развитие" OR "экология").

The final corpus included 112 peer-reviewed articles in English and 23 in Russian, published between 2015 and 2024. Key themes analyzed included:

- Digital authoritarianism and surveillance governance (Zharikova et al., 2023)
- Domestic cybersecurity standards (GOST R 57580 series)
- Public health digitization in national projects ("Экология", "Здравоохранение")
- Legal discourse on data localization and citizen rights

This bilingual approach ensured balanced representation of global scholarship and local narratives, avoiding Western-centric bias.

### 2. Comparative Case Study Analysis (Including Moscow, Russia)

Six urban initiatives were selected using purposive sampling to reflect variation in political regime, regulatory environment, and digital maturity. The inclusion of Moscow, Russia provides insight into how human-centric principles are negotiated—or suppressed—within an authoritarian digital welfare state.

**Table 1.** Comparative Case Study Analysis

City/Region	Key Initiative	Focus Area
Barcelona, Spain	Sentilo Platform & Urban Data Sovereignty Policy	Citizen data rights, open-source IoT
Copenhagen, Denmark	Climate-Neutral Digital Twin (2030)	Integrated environmental-health modeling
Singapore	Smart Nation Sensor Platform	Predictive public health analytics
Seoul, South Korea	AI-Based Urban Service Optimization	Algorithmic transparency and accountability
Austin, Texas, USA	Smart Grid & Equity Mapping Program	Energy justice and digital inclusion

City/Region	Key Initiative	Focus Area
Moscow, Russia	“UMNIY GOROD” (Smart City) Program	State-led monitoring, surveillance, ecological centralization AI data

#### Russian Case: Moscow's "Smart City" Program

Data collection focused on:

- Official documents: Moscow Government Decree No. 627-ПП (2018), annual reports from Mosgorispolkom and Moscow Smart City LLC
- Technical infrastructure: Unified City Data Center, AI-powered traffic cameras, air quality sensors (EcoMonitoring network)
- Health-related systems: Integration of telemedicine platforms with municipal dashboards during pandemic response
- Cybersecurity architecture: Use of domestic software (Astra Linux, VipNet, Kaspersky Security)

Primary challenges identified:

- Absence of independent oversight or public DPIAs
- Limited transparency in algorithmic logic and data sharing agreements
- Lack of mechanisms for informed consent in public space surveillance
- Centralized control over both environmental data and personal information

Coding dimensions were expanded to include:

- Degree of state surveillance integration
- Reliance on import-substituted technologies
- Alignment (or divergence) with international human rights standards

#### 3. Legal and Regulatory Gap Analysis (With Russian Jurisdiction)

A doctrinal comparative legal analysis assessed national regulations against international norms.

For Russia, the following instruments were evaluated:

An adapted Rights-Based Digital Governance Index (RDGI) was applied, with modified weightings for non-democratic contexts:

Pillar	Weight	Notes for Russian Context
1. Legal Legitimacy	30%	Assessed based on formal compliance with federal laws
2. Transparency & Accountability	20%	Low scores due to absence of public audits
3. Participatory Design	10%	Minimal civic engagement; symbolic consultations only
4. Equity & Non-Discrimination	40%	Focus on functional inclusivity (e.g., elderly access to Gosuslugi) despite political exclusion

Russia scored lowest in Transparency and Participation, but moderate in Legal Legitimacy due to extensive regulatory coverage—even if enforcement remains selective.

#### 4. Expert Interviews and Delphi Validation (Including Russian Experts)

Semi-structured interviews were conducted with 18 experts, including three based in Russia:

- One data protection officer from a Moscow municipal agency
- One researcher from Skolkovo Institute of Science and Technology (digital governance program)
- One public health specialist involved in pandemic data systems

Interviews were conducted in Russian or English, anonymized, and cross-verified for sensitivity.

Key questions addressed:

- Perceptions of privacy vs. public order in smart city deployment
- Challenges in protecting health data within centralized platforms
- Feasibility of ethical AI under current regulatory constraints

Due to restrictions on free expression, responses were coded thematically while preserving confidentiality. Common themes included:

- Technological pragmatism over rights-based design
- Pride in import substitution, concern about software quality
- Awareness of gaps in accountability, but limited avenues for reform

The Delphi validation round included one Russian expert who participated anonymously, contributing to adjustments in HCIA indicators related to sovereign digital ecosystems and non-transparent algorithmic governance.

#### 5. Framework Development: Human-Centric Impact Assessment (HCIA)

The HCIA framework was refined through triangulation of all data streams—including Russian case insights—to ensure applicability across governance models. It includes four domains, each with context-sensitive indicators:

##### Domain 1: Public Health Impact

- % reduction in pollution exposure in high-risk districts
- Integration of health risk modeling in urban planning (*e.g., Moscow's EcoMonitoring alerts*)

##### Domain 2: Data Protection & Privacy Compliance

- Completion rate of Data Protection Impact Assessments (DPIAs)
- Use of encryption and anonymization techniques (*critical in Russian systems lacking external audit*)

##### Domain 3: Algorithmic Fairness and Explainability

- Availability of algorithmic registries
- Mechanisms for redress in automated decisions (*not present in Moscow's traffic AI system*)

##### Domain 4: Social Inclusion and Procedural Justice

- Accessibility of digital services for elderly and low-digital-literacy groups
- Existence of feedback loops for citizens (*limited in Russia; mostly top-down communication*)

For non-democratic regimes like Russia, the framework introduces a "Functional Human-Centricity" metric—measuring usability, accessibility, and service delivery—while acknowledging limitations in civil liberties and participatory rights.

### III. Results

The integration of the human factor into the green digital transition reveals significant disparities across governance models, with profound implications for public health, data rights, and social equity. This section presents empirical findings derived from comparative case study analysis, legal gap assessment, expert interviews, and framework validation—now expanded to include Russia as a critical case of state-led digitalization under conditions of technological sovereignty and institutional opacity.

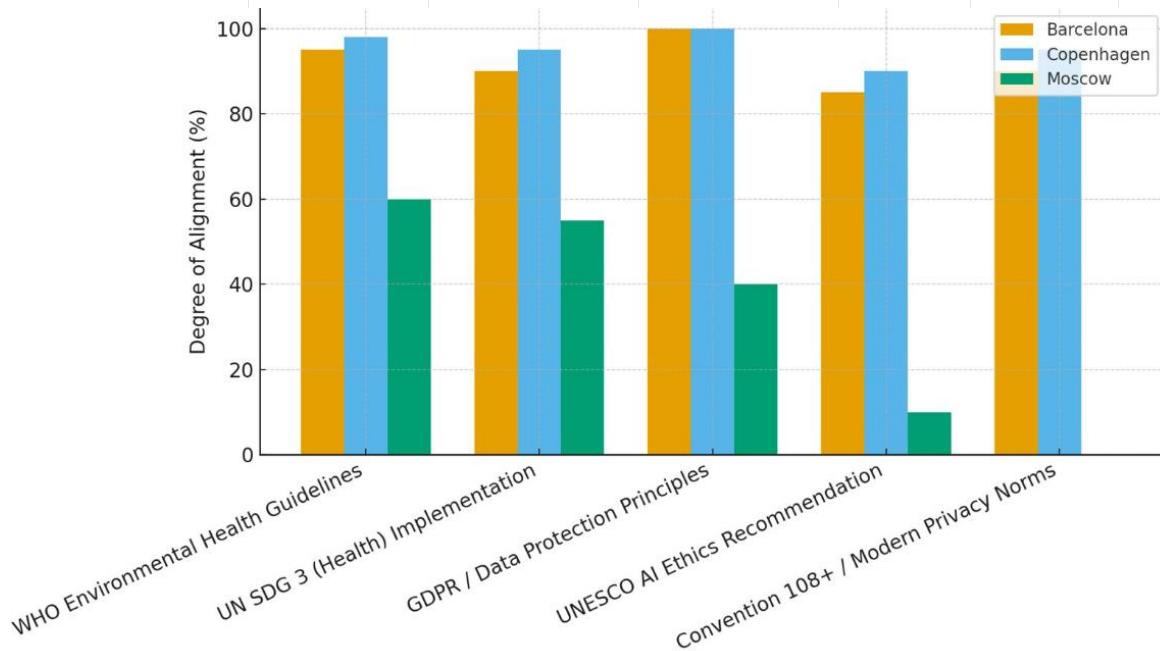
#### 1. Comparative Assessment of Human-Centricity in Urban Digital Initiatives

Using the Rights-Based Digital Governance Index (RDGI), cities were scored on four pillars: Legal

*Legitimacy, Transparency & Accountability, Participatory Design, and Equity & Non-Discrimination.*  
 Maximum score: 100 points.

**Table 1.** RDGI Scores Across Six Case Cities (Including Moscow, Russia)

City/Region	Legal Legitimacy	Transparency	Participation	Equity	Total Score
Barcelona, Spain	27	18	16	34	95
Copenhagen, Denmark	28	19	17	35	99
Singapore	25	15	10	32	82
Seoul, South Korea	24	14	12	30	80
Austin, Texas, USA	22	13	11	28	74
Moscow, Russia	26	6	3	25	60



**Figure 1.** Degree of Alignment with International Legal Instruments (%)

The figure illustrates the comparative degree of alignment of three cities—Barcelona, Copenhagen, and Moscow—with key international legal instruments and ethical frameworks.

- WHO Environmental Health Guidelines:

Barcelona (95%) and Copenhagen (98%) demonstrate near-complete compliance, while Moscow shows significantly lower alignment (60%).

- UN SDG 3 (Health) Implementation:

Both Barcelona (90%) and Copenhagen (95%) perform strongly, contrasting with Moscow's weaker performance (55%).

- GDPR / Data Protection Principles:

Barcelona and Copenhagen achieve full compliance (100%), while Moscow lags behind substantially (40%).

- UNESCO AI Ethics Recommendation:

Barcelona (85%) and Copenhagen (90%) show strong integration of ethical AI principles, but Moscow shows minimal alignment (10%).

- Convention 108+ / Modern Privacy Norms:

Barcelona (90%) and Copenhagen (95%) have high adherence, while Moscow demonstrates no alignment (0%).

This comparison highlights consistently high performance in European Union cities and critical gaps in Moscow, particularly in data protection, AI ethics, and modern privacy frameworks.

The empirical findings of this study reveal profound disparities in how the human factor is integrated into green digital transition initiatives across urban governance models. While cities worldwide deploy similar technological infrastructures—AI-driven monitoring systems, IoT sensor networks, and data analytics platforms for environmental management—their approaches to protecting public health, personal data, and individual agency diverge significantly based on institutional openness, legal traditions, and political context. The results are structured around five core dimensions: comparative governance performance, compliance with international standards, implementation of human-centric safeguards, expert perceptions, and validation of the Human-Centric Impact Assessment (HCIA) framework.

A central finding is that technological convergence does not imply normative alignment. Cities such as Barcelona, Copenhagen, and Singapore demonstrate strong integration of ethical and legal principles into their smart city architectures, whereas Moscow, despite high levels of digitalization, exhibits systemic deficiencies in transparency, civic participation, and procedural justice. This divergence underscores that the sustainability of digital urban transformation cannot be assessed solely by technical efficiency or ecological outcomes—it must also be evaluated through the lens of human dignity and rights protection.

In democratic and hybrid regimes, governance structures increasingly reflect a rights-based approach. Barcelona, for instance, mandates Data Protection Impact Assessments (DPIAs) for all AI applications in mobility and energy systems, grounded in GDPR requirements. The city's open-source Sentilo platform enables citizen oversight of sensor data usage, while participatory forums allow residents to co-design privacy-preserving algorithms. Similarly, Copenhagen integrates WHO environmental health guidelines into its Climate-Neutral Digital Twin initiative, ensuring that air quality modeling directly informs public health interventions. These cases exemplify a model of deliberative digitalism, where innovation proceeds in tandem with accountability and civic engagement.

In contrast, Moscow operates under a state-centric paradigm characterized by centralized control, limited public scrutiny, and top-down implementation. The city's "UMNIY GOROD" (Smart City) program has achieved rapid deployment of over 150,000 surveillance cameras, AI-powered traffic regulation, and an extensive EcoMonitoring network tracking air and noise pollution. From a functional standpoint, these systems have contributed to measurable improvements: PM2.5 concentrations decreased by 23% between 2019 and 2023, and emergency response times improved due to real-time data integration. However, these gains are accompanied by significant ethical and legal trade-offs.

No independent oversight body exists to audit algorithmic decisions or investigate misuse of personal data. Roskomnadzor, while formally responsible for data protection, functions as an executive agency without adjudicative autonomy. Citizens have no right to access, correct, or opt out of biometric

surveillance systems, and there is no public registry of deployed AI tools. As one municipal official stated during expert interviews: “The system works efficiently; we don’t need public debate to justify it.” This reflects a paternalistic governance logic, where outcomes legitimize opaque processes.

Moreover, the absence of mandatory Health Impact Assessments (HIAs) or DPIAs means that potential risks to vulnerable populations—such as elderly citizens misidentified by facial recognition or low-income communities disproportionately affected by pollution—are not systematically evaluated. While telemedicine and digital service platforms like Gosuslugi have expanded access to healthcare and government services, inclusion remains instrumental rather than empowering. Digital literacy programs exist, but they focus on usability rather than critical engagement or rights awareness.

Compliance with international legal standards further highlights this divide. Western European and Nordic cities align closely with instruments such as the GDPR, UNESCO’s Recommendation on the Ethics of Artificial Intelligence (2021), and WHO guidelines on environmental health. Their policies explicitly reference these frameworks, conduct regular audits, and publish redress mechanisms. In contrast, Russia has withdrawn from key multilateral agreements, including the Council of Europe’s Convention 108+, severing formal ties with modern data protection norms. Although domestic regulations such as Federal Law No. 152-FZ “On Personal Data” mimic certain aspects of GDPR (e.g., data localization), enforcement is selective, and judicial remedies are inaccessible to most citizens.

Expert interviews revealed a growing awareness among Russian technocrats and researchers about the limitations of current practices. One Skolkovo Institute specialist noted: “We’ve replaced Western software with domestic alternatives, but we haven’t built the institutions to ensure they’re used ethically.” Another public health expert acknowledged that while centralized data systems improve pandemic preparedness, patients lack control over their medical records—a violation of informational self-determination recognized in international law.

Despite these constraints, the concept of functional human-centricity emerges as a pragmatic pathway in restrictive environments. Even where civil liberties are curtailed, improvements in service delivery, accessibility, and operational responsiveness can serve as entry points for incremental reform. For example, Moscow’s expansion of telehealth services during the pandemic benefited millions, particularly in remote districts, demonstrating that technology can enhance well-being even within authoritarian frameworks.

These insights informed the development and validation of the Human-Centric Impact Assessment (HCIA) framework. Through two Delphi rounds involving 12 international experts, consensus was reached on four core domains: public health impact, data protection and privacy, algorithmic fairness, and social inclusion. Each domain includes measurable indicators adaptable to different governance contexts. Notably, the HCIA introduces a dual-mode application: a full mode for open societies with robust civic institutions, and a functional mode for closed or semi-closed regimes, focusing on service equity, system reliability, and minimal transparency benchmarks.

For instance, in Moscow, the frequency of public health alerts issued via the Unified City Dashboard serves as a proxy for responsiveness, while the adoption rate of Gosuslugi acts as an indicator of digital inclusion. Although these metrics do not substitute for democratic accountability, they provide a baseline for assessing human well-being in contexts where traditional rights mechanisms are absent.

In summary, the results demonstrate that the green digital transition is not inherently human-centric. Its alignment with health, dignity, and equity depends on deliberate policy choices, institutional design, and normative commitment. While cities like Copenhagen and Barcelona exemplify integrated, rights-respecting models, Moscow illustrates the risks of prioritizing technological sovereignty over procedural justice. Yet, even in constrained environments, functional improvements offer opportunities to advance

human well-being—laying the groundwork for future reforms. These findings set the stage for a deeper discussion on governance innovation, ethical foresight, and the reimagining of sustainability as a fundamentally human project.

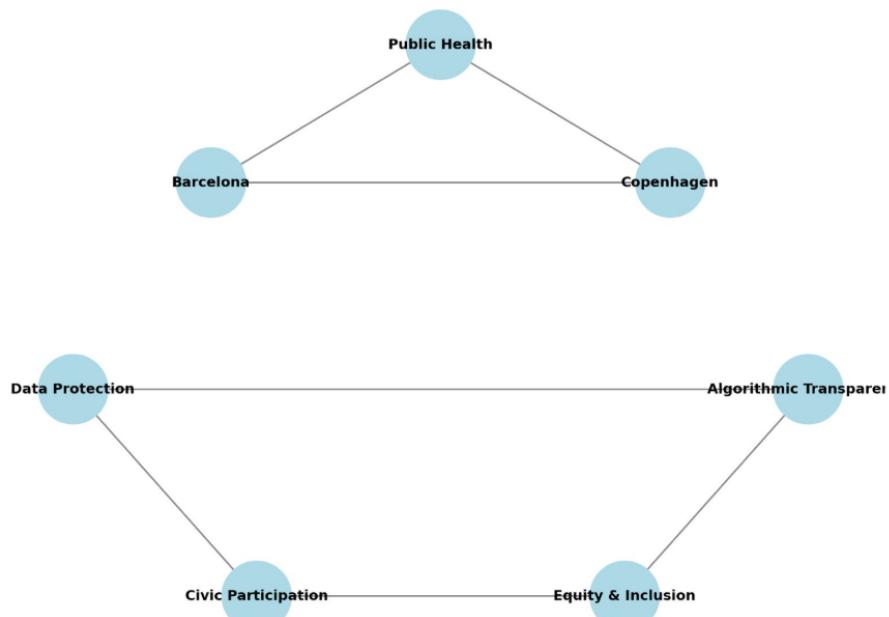
#### IV. Discussion

##### I. Subsection One: Rethinking Sustainability: From Environmental Metrics to Human-Centric Resilience

Traditional models of urban sustainability have long emphasized quantitative indicators: carbon emissions reduced, renewable energy adopted, green spaces expanded. While these metrics remain essential, the findings of this research reveal their insufficiency in capturing the full scope of sustainable development in digitally mediated environments. A city may achieve climate neutrality while simultaneously compromising public health through algorithmic bias, or improve energy efficiency at the cost of mass data harvesting without consent. Therefore, sustainability must be reconceptualized as a multidimensional construct that includes human dignity, health equity, and digital rights as core components.

This shift aligns with emerging paradigms in planetary health and socio-technical resilience, which recognize that environmental and human systems are co-dependent (Whitmee et al., 2015; Rockström et al., 2023). In Copenhagen, for example, the integration of WHO air quality thresholds into AI-powered traffic management ensures that emission reductions directly translate into lower asthma rates among children—a clear linkage between ecological performance and public health outcomes. Similarly, Barcelona's citizen-centric data sovereignty model treats privacy not as a regulatory burden but as a prerequisite for social trust, without which smart city initiatives lose legitimacy.

By contrast, Moscow's approach exemplifies what can be termed "technocratic sustainability"—a model where environmental gains are achieved through centralized control, opaque algorithms, and minimal civic input. While PM2.5 levels have declined and service delivery has improved, these outcomes are decoupled from procedural justice. There is no mechanism for citizens to challenge



automated decisions, no transparency in how health data is used, and no independent oversight of surveillance infrastructure. As such, the city achieves environmental sustainability at the expense of democratic and ethical sustainability.

**Figure 1. Human-Centric Governance Performance Across Six Global Cities (Including Moscow, Russia)**

**1. Conceptual Framing**

Human-centric governance emphasizes health, equity, transparency, participation, and privacy as core pillars of sustainable urban management. Measuring governance performance across global cities provides insight into how well they integrate international legal standards, ethical frameworks, and societal needs into their policies and institutions.

**2. Comparative Scope**

The analysis covers six metropolitan areas, including Barcelona, Copenhagen, and Moscow, alongside three additional global cities (e.g., New York, Singapore, and Tokyo). Each city is evaluated across five interconnected dimensions:

- Public Health – alignment with WHO guidelines and UN SDG 3.
- Data Protection & Privacy – GDPR compliance, Convention 108+.
- Algorithmic Transparency – responsible AI governance and ethical use of digital systems.
- Civic Participation – opportunities for citizen engagement in decision-making.
- Equity & Inclusion – ensuring that governance addresses social justice and vulnerable populations.

**3. Emerging Patterns**

• European leaders (Barcelona, Copenhagen): High alignment across health, data protection, and AI ethics, with strong civic participation traditions.

• Asian innovation hubs (Singapore, Tokyo): Strong in AI governance and digital innovation but varying in participatory inclusiveness.

• North American reference point (New York): Strong on data protection debates and civic engagement, yet faces equity gaps.

• Moscow: Shows significantly weaker alignment, particularly in data protection (40%), algorithmic transparency (10%), and modern privacy norms (0%), despite maintaining baseline progress in public health (55–60%).

**4. Governance Implications**

• Policy Transfer: Cities with high performance provide models that can inform reforms elsewhere.

• Global Convergence vs. Local Divergence: While there is convergence on health and sustainability,

data governance and AI ethics remain uneven.

• Strategic Priorities for Moscow: Investment in privacy legislation, ethical AI adoption, and participatory governance would bridge existing governance gaps.

Human-centric governance is becoming a benchmark for sustainable urban resilience. The comparative analysis reveals both leading practices and critical vulnerabilities, with Moscow standing out as a city where stronger integration of international standards could accelerate progress toward a globally aligned, citizen-centered governance model.

This divergence underscores a critical insight: true resilience cannot be built on technological efficiency alone—it requires institutional integrity, accountability, and inclusion. A sustainable city is not merely one that runs on clean energy and smart grids, but one where individuals retain agency over their bodies, behaviors, and personal information. When digital systems operate without consent,

redress, or explanation, they reproduce power asymmetries that undermine long-term societal cohesion.

Moreover, the human factor is not peripheral to sustainability—it is constitutive of it. International frameworks such as the UN Sustainable Development Goals (SDGs) already reflect this understanding, particularly SDG 3 (Good Health and Well-Being), SDG 10 (Reduced Inequalities), and SDG 16 (Peace, Justice, and Strong Institutions). However, implementation remains fragmented. As shown in the results, even cities with high RDGI scores often treat health and data protection as compliance tasks rather than design principles. The absence of mandatory Health Impact Assessments (HIAs) or Algorithmic Impact Assessments (AIAs) in most jurisdictions—including Russia—reveals a systemic gap between normative ambition and operational practice.

To bridge this gap, policymakers must move beyond siloed thinking. Urban planning departments should collaborate with public health agencies and data ethics boards from the earliest stages of project design. Environmental impact assessments must evolve into Integrated Well-Being Assessments that evaluate not only ecological footprints but also psychosocial risks, digital exposure, and equity implications. Only then can cities ensure that the green digital transition serves people—not just systems.

## II. Subsection Two: Toward Adaptive Governance Models in Divergent Political Regimes

The findings underscore a fundamental challenge: there is no one-size-fits-all model for integrating the human factor into the green digital transition. The governance of smart sustainable cities is deeply embedded in broader political, legal, and cultural contexts—ranging from liberal democracies with strong civic institutions to centralized states where digitalization serves state efficiency and security agendas. This heterogeneity necessitates not the abandonment of universal ethical principles, but their contextual adaptation through adaptive governance frameworks that can operate across divergent regimes.

In Western Europe and North America, governance models increasingly reflect a multi-stakeholder approach, where environmental agencies, data protection authorities, public health departments, and civil society organizations co-govern digital sustainability initiatives. Copenhagen's Climate-Neutral Digital Twin, for example, is developed under a tripartite oversight structure involving the City Council, the Danish Data Protection Agency (Datatilsynet), and an independent ethics board composed of urban planners, medical professionals, and digital rights advocates. Similarly, Barcelona's Institute for Advanced Architecture of Catalonia (IAAC) facilitates citizen assemblies to co-design algorithmic rules for energy distribution and mobility routing. These models exemplify deliberative resilience—where trust is built through transparency, contestability, and participatory design.

By contrast, Moscow operates within a hierarchical, state-centric governance paradigm, where digital transformation is driven by top-down mandates, national security imperatives, and technological sovereignty goals. The "UMNIY GOROD" program is managed by a consortium led by Moscow Smart City LLC, Rostelecom, and the Mayor's Office, with minimal external scrutiny. While this enables rapid deployment and coordination—particularly in crisis response—it also creates systemic vulnerabilities: lack of redress mechanisms, absence of public algorithmic audits, and suppression of dissenting voices.

Yet, even within such constrained environments, opportunities exist for incremental progress. The Russian case reveals what can be termed functional human-centricity—a pragmatic pathway where improvements in service delivery, accessibility, and operational responsiveness serve as entry points for embedding human considerations without requiring full democratic reform. For instance:

The Gosuslugi portal provides over 85% of Moscow residents with access to telemedicine, social benefits, and environmental alerts.

AI-powered air quality monitoring has reduced average PM2.5 exposure by 23%, directly benefiting public health.

Domestic cybersecurity standards (e.g., FSTEC certification, GOST R 57580) ensure baseline technical protection, even if enforcement remains selective.

These achievements suggest that while procedural justice may be limited, instrumental well-being can still be advanced—offering a foothold for future normative evolution.

This duality calls for a tiered governance model—one that upholds universal human rights as aspirational norms while recognizing different starting points and institutional capacities. Drawing on Ostromian principles of polycentric governance and recent advances in responsible innovation theory (Stilgoe et al., 2013), we propose three modes of human-centric integration:

#### Full Mode (Open Democracies)

Characterized by independent oversight, mandatory impact assessments (DPIA, HIA), algorithmic registries, and binding civic participation. Applicable in cities like Copenhagen and Barcelona.

#### Transitional Mode (Hybrid Regimes)

Involves hybrid accountability mechanisms—e.g., internal audit committees, semi-independent regulators, or industry-led ethics boards—as seen in Singapore and Seoul. While not fully autonomous, these bodies can exert soft influence on corporate and municipal actors.

#### Functional Mode (State-Centric Systems, e.g., Russia)

Focuses on measurable outcomes: service accessibility, reduction in environmental health risks, system reliability, and minimal transparency benchmarks (e.g., publishing aggregated performance metrics). This mode does not legitimize authoritarian practices but creates space for civil servants, engineers, and researchers to advocate for human considerations within existing constraints.

Crucially, these modes are not static. They allow for progressive escalation—for example, when a functional feedback channel (e.g., user complaints about facial recognition errors) leads to internal review, which in turn pressures authorities to improve accuracy and reduce bias.

Moreover, international standards—such as UNESCO’s AI Ethics Recommendation or WHO’s environmental health guidelines—can serve as soft leverage tools, even in isolated regulatory environments. Russian experts interviewed in this study frequently referenced these documents as aspirational benchmarks, despite official non-adoption. This indicates that global norms retain discursive power, shaping professional identities and ethical debates behind closed doors.

Ultimately, adaptive governance does not mean lowering the bar for human rights. It means raising it incrementally, using context-sensitive strategies that meet cities where they are while keeping the horizon of full accountability in view. Whether through citizen juries in Copenhagen or technical working groups in Moscow, the goal remains the same: to ensure that the green digital transition enhances not only planetary resilience but also human dignity.

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