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NEW CHALLENGES FOR XXI CENTURY CITIES

Multilevel scientific approach to impacts of global warming on urban areas,
energy transition, optimisation of land use and emergency scenario

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TeMA Journal was established with the primary objective of fostering and strengthening the integration between urban transformation studies and those focused on mobility governance, in all their aspects, with a view to environmental sustainability. The three issues of the 2025 volume of TeMA Journal propose articles that deal with the effects of Global warming, reduction of energy consumption, immigration flows, optimization of land use, analysis and evaluation of civil protection plans in areas especially vulnerable to natural disasters and multilevel governance approach to adaptation.

TeMA is the Journal of Land Use, Mobility and Environment and offers papers with a unified approach to planning, mobility and environmental sustainability. With ANVUR resolution of April 2020, TeMA journal and the articles published from 2016 are included in the A category of scientific journals. The articles are included in main scientific database as Scopus (from 2023), Web of Science (from 2015) and the Directory of Open Access Journals (DOAJ). It is included in Sparc Europe Seal of Open Access Journals, and the Directory of Open Access Journals.

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REVIEW NOTES – Urban strategies, programmes and tools

Digitalization in urban planning: new digital technologies for sustainable cities

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Abstract

Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always remaining in the groove of rigorous scientific in-depth analysis. This section of the Journal, Review Notes, is the expression of continuously updating emerging topics concerning relationships between urban planning, mobility and environment, through a collection of short scientific papers written by young researchers. The Review Notes are made of four parts. Each section examines a specific aspect of the broader information storage within the main interests of TeMA Journal. In particular, the Urban strategies, programmes and tools section presents the different strategies and tools that guide the digitalization of urban planning.

This paper explores digitalization in urban transformation, with a specific focus on sustainability and how digital technologies act as catalysts for the achievement of environmental, social and economic sustainability goals.

Concrete examples are presented of strategies and plans implemented by some cities, New York, Amsterdam and Turin, that have successfully integrated digital to address complex challenges such as climate change, resource management and citizen well-being, demonstrating the potential of digitalization to influence urban governance.

Keywords

Digital cities; Sustainable; Urban strategies; Technologies; Digitalization

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1. More sustainable and digital cities

The digital revolution is profoundly transforming urbanity, redefining the way cities are designed, managed and experienced. It is not just the introduction of new technologies, but a radical shift in resource management and urban governance. More and more cities are trying to integrate digital and technological solutions to improve citizens' quality of life, optimize resource use, reduce environmental impact, and promote sustainable and inclusive urban development.

Through the use of new technologies cities can increase their "realm of possibilities" (Łaźniewska et al., 2021) in various areas, such as the economic, social, and organizational ones.

In 1987, the World Commission on Environment and Development, WCED, established in 1983, presented the report "Our Common Future" (also known as the Brundtland Report after the Commission's president), formulating a guideline for sustainable development that is still valid today.

The basic pillars of sustainability are commonly recognized in three interconnected and interdependent dimensions: environmental, social and economic. The concept of sustainable development aims precisely to balance these three dimensions and enable "the present generation to meet its own needs without compromising the ability of future generations to meet theirs" (United Nations, 1987).

For those who govern the territory, sustainability is a thread that directly links and influences a number of strategic objectives and has substantial effects on urban areas (Goldman & Gorham, 2006; Oguz & Tanyas, 2024), their functioning, their development and the quality of life of their inhabitants.

1.1 Digital for environmental sustainability

Environmental sustainability focuses on maintaining the health and productivity of our planet, safeguarding ecosystems and biodiversity so as not to jeopardize the future of the next generation. Its primary goals include the responsible management of natural resources, whether renewable such as water and soil or nonrenewable such as fossil fuels. It is also crucial to reduce air and water pollution and toxic waste generation, combat climate change through mitigation and adaptation, promote a circular economy, and protect biodiversity.

The Internet of Things (IoT), sensors and Big Data enable cities to collect a huge amount of real-time information on traffic, energy consumption, air quality, people flows and more. This data is critical for more informed and evidence-based urban planning, enabling optimization of land use, transportation networks, and infrastructure development.

The digital revolution offers powerful tools to promote environmental sustainability on multiple fronts. For better management of natural resources, the integration of digital and communication technologies (ICT) with physical infrastructure (power grids, water, transportation networks, etc...) optimizes energy distribution and consumption, integrating renewable sources and reducing waste. Intelligent monitoring systems in buildings, industry, and agriculture make it possible to cut consumption and reduce environmental impact. Carbon footprint reduction is supported by emission calculation and monitoring platforms, incentivizing more sustainable practices and tracking progress toward climate neutrality.

Technological innovations associated with the concept of the smart city are increasingly linked to the need for a "resilient city" in response to urgent urban needs. These two concepts are interrelated and contribute together to the transformation of cities into "human cities," cities on a human scale where human well-being, quality of life and the urban environment, and the preservation of resources are central to decisions regarding land management (Pirlone et al., 2022; Hoyle, 1988).

The Covid-19 crisis has had major consequences for the development of smart technology concepts and has accelerated the digitalization of life and work (Boujari et al., 2024).

The digital revolution is making urban services much more efficient and optimized. For mobility, advanced artificial intelligence-based systems are managing traffic, while multimodal mobility apps and smart car/bike sharing services, such as those offered under MaaS, combined with electric vehicle infrastructure, are helping

to dramatically reduce congestion, pollution and travel time. For sustainable waste management, IoT and artificial intelligence-based solutions improve waste collection, optimize disposal routes, and promote the circular economy.

Some cities are implementing major strategies to modernize infrastructure, bridge digital divides, and improve capital planning processes to accelerate major infrastructure upgrades such as roads, water systems, sewer systems, parks, and libraries. New York City, for example, continues to advance cutting-edge approaches to anticipate future needs, improve capital planning practices, and direct resources based on factors such as demographic changes, climate change impacts, equity improvements, and community perspectives. Another example is the city of Singapore, universally recognized as a leader in the transformation to a “Smart Nation,” an ambitious initiative focused on integrating data and technology to address urban challenges typical of a densely populated city-state, such as resource management, mobility, aging population and environmental sustainability.

New York (USA) – OneNYC 2050 Strategic Plan

NYC CPP (New York City Climate Policy & Programs) manages OneNYC 2050, New York City’s long-term strategy launched in 2019, and the Green New Deal to secure the city’s future against the challenges of today and tomorrow. The ambitious plan is based on the belief that the struggles for environmental sustainability, economic equality and social justice are deeply interconnected.

OneNYC 2050 consists of 8 goals and 30 initiatives that make up a strategy to prepare new york city for the future. The goals reflect both the city’s core strengths and the significant challenges it will face (OneNYC 2050, 2019):

- *a vibrant democracy*, where every New Yorker is welcomed into the civic and democratic life of the city;
- *an inclusive economy*, where economic growth creates opportunities for all New Yorkers and safeguards the American Dream;
- *thriving neighborhoods*, where all communities have safe, affordable housing and are well served by parks, cultural resources, and other shared spaces;
- *healthy lives*, where health inequities based on race and ethnicity are eliminated, and all residents have equal access to health care, clean air, and healthy food;
- *equity and excellence in education*, where diverse and fair schools provide a quality education for every student;
- *a livable climate*, where we no longer rely on fossil fuels and have mitigated the risks posed by climate change;
- *efficient mobility*, where affordable, reliable, safe, and sustainable transportation options mean no New Yorker needs to rely on a car. Because New York City’s transit system and walkability are core to our identity, economic competitiveness, and quality of life;
- *modern infrastructure*, where reliable physical and digital infrastructure allows New Yorkers to flourish.

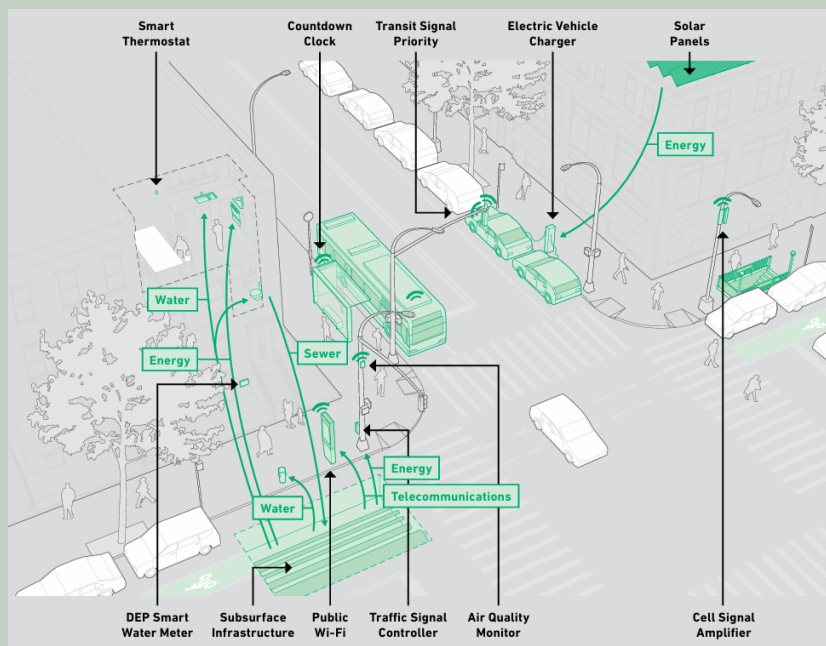


Fig.1 A connected city (OneNYC 2050, 2019)

Among many goals, the Plan promotes the use of new technologies to achieve 80 percent sustainable mode of travel by 2050. To do this, the city is deploying traffic management systems based on Artificial Intelligence and employing thousands of sensors and connected devices (IoT) to monitor flows (of people and vehicles), optimize travel times, improve safety, and reduce congestion and emissions. Another successful implementation of smart technologies has been applied in the city's automatic water meter reading system that connects residents to water consumption data, saving millions of dollars since its launch.

1.2 Digital for social sustainability

Social sustainability concerns the ability to ensure equitable and inclusive conditions of human and social well-being by promoting social justice, equality, health, education, and participation of all community members. Its primary goal is to promote social justice and equality by reducing disparities in income and in access to services and opportunities (access to employment, health, education, etc.). Also crucial are the participation and inclusion of each community in decision-making processes.

Achieving these goals can be encouraged by the use of new technologies. Digital can facilitate access to education (e-learning and digital educational resources), health (telemedicine) and public services even in remote areas or for disadvantaged segments of the population, helping to reduce the "digital divide" and promote social equity. Consider, for example, the increasingly popular "Digital Public Services," online platforms for certificates, payments, appointments and communications between citizens and the administration that make services more accessible and efficient.

The use of data and digital technologies can increase the sense of equity and social justice; digital technologies can increase transparency in public decisions and business operations, helping to combat corruption and promote more ethical practices.

The digital revolution is also transforming the way citizens participate in the life of their community. Digital platforms offer new opportunities to actively involve people in urban decision-making processes. With these tools, citizens can easily voice their opinions, report problems or disservices, and directly contribute to the design and management of public spaces. In this way, technology becomes a bridge between the administration and residents, fostering broader and more inclusive participation in civic life.

Many cities are integrating social sustainability into their strategic plans through the use of new digital technologies. A significant example is the Italian city of Turin, with its "Digital Strategy 2024/2028" by which it places digital transformation as a cross-cutting lever for sustainable, ethical and inclusive development of the city. Barcelona promotes social cohesion and inclusivity with digital by developing an online platform, "Decidim Barcelona" an open-source software that allows citizens to propose ideas, discuss and vote on issues related to the city, from urban planning to participatory budgets by incentivizing their participation in civic life and decision-making processes (Aragón et al., 2017).

At the European level, several policy directions frame the strategic actions of cities that seek to embrace and integrate digital technologies into every aspect of their governance. Among the normative references are "The New Leipzig Charter" (2020) and "The Digital Decade policy program 2030": the former, implements what has already been established in the European Urban Agenda and describes the future evolution of urban centers according to three strands: Inclusion and Cohesion, Ecology, Productivity, and Connectivity; the latter, represents the "digital compass" for EU countries and will support the prospects for Europe's digital transformation by 2030 for a people-centered, sustainable, and more prosperous digital future.

Torino (ITALY) – Digital Strategy 2024/2028

The Digital Strategy of the City of Turin for the five-year period 2024 - 2028 was developed with the objective of defining and sharing the directives that will guide the City's ICT initiatives towards completion of the digital transition. The City's digital strategy defines a "Citizen-Centric" digital transformation model within which four strategic objectives are declined:

- Centrality of the person and relationship with the territory
- Value of data for the City
- Security and resilience of digital services
- Digital administration

The Strategy aims to define services that will enhance the dialogue and relationship between the city and various stakeholders, responding to the specific needs of citizens and businesses. The goal is to reduce the gap between the city and people. This will be possible thanks to digital technologies that will be enabling factors in creating value in terms of opportunities, inclusion, improved quality of life, competitiveness, innovation and simplification of administrative processes.



Fig.2 A digital city (AI generated image by author)

1.3 Digital for economic sustainability

Economic sustainability refers to the ability to generate wealth and jobs in a sustainable way, ensuring a fair income, responsible consumption and efficient management of financial resources, without depleting natural or social capital.

Our current way of producing and consuming has a huge impact on the environment and on our society. It is becoming increasingly clear that something has to change.

Economic sustainability aims at fair and inclusive growth that reduces poverty by optimising the use of natural, human and financial resources. It requires sustainable innovation to develop responsible technologies and business models, while building economic systems resilient to external shocks (financial crises, climate change). It is also crucial to promote corporate responsibility with ethical and transparent practices.

The implementation of technologies increases the efficiency of production and management processes of companies that are helped in optimising energy consumption, reducing operating costs and resources used, also to the benefit of the environment.

Digital technologies enable the creation of innovative services and products, new markets as well as new sustainable business models (such as e-commerce, digital start-ups, Mobility as a Service, etc.). Moreover, digitisation is an enabling factor for the transition towards a circular economic model with platforms that can facilitate product traceability, reuse, recycling and resource sharing.

In this context, cities play a crucial role and digital becomes a key enabler for the implementation of strategies and plans for a more sustainable urban future and economic growth. Many cities develop clear roadmaps with specific goals to achieve economic sustainability targets supported by a smart use of technology. Examples are the city of Amsterdam that has adopted the Amsterdam Circular Strategy 2020-2025 with the ambitious goal of becoming 100% circular by 2025, or the city of Milan that is developing innovative projects such as

"BOTTO" an automatic communication system that facilitates the redistribution of surplus food between wholesalers and associations fighting food waste, exploiting digital technology. The city of Lahti (Finland), European Green Capital 2021, also shines for having promoted economic sustainability with an integrated strategy that combined digitalization, circular economy and citizen involvement (Lombardini et al., 2025).

Amsterdam (NETHERLANDS) – *Amsterdam Circular Strategy 2020-2025*

Amsterdam stands out globally for its ambitious commitment to the circular economy, with the goal of becoming a fully circular city by 2050 and halving the use of new raw materials by 2030. Its main plan and tool to achieve these goals is the *Amsterdam Circular Strategy 2020-2025* (2020), a strategic roadmap based on the "Doughnut Economy" model. The City's strategy is a pragmatic approach that combines long-term vision with concrete actions in the short and medium term that focus on three value chains:

- Food & organic waste streams, to create a robust and sustainable food system, reducing food waste and ensuring high-quality processing of organic waste;
- Consumer goods, to reduce consumption and extend the useful life of products, maximizing the value of discarded goods;
- Built environment, towards a circular development in the construction sector, reducing the use of virgin materials and promoting the reuse of existing ones.

The city of Amsterdam adopts two approaches to achieve its goals: the first is top-down, as a city, it indicates what it wants to achieve and how it wants to get there; the second is a bottom-up approach, giving space to circular projects and initiatives to be accelerated and expanded.

The Amsterdam plan for the circular economy is an ambitious and concrete example of how a city can strategically plan the transition to a more sustainable model.



Fig.3 "Amsterdam Circular 2020-2025" Strategy (2020)

2. Conclusion

The digital revolution offers unprecedented opportunities for cities to become more efficient, sustainable, resilient and citizen-friendly.

Today, innovation is considered to be at the heart of territorial regeneration and this new vision is manifested in modern planning strategies, which favour participatory, multi-level methods that exploit new digital tools.

A global approach to sustainable urbanization and energy transition is spreading (Pidalà, A. M., 2025). Among the tools deployed by cities are PEDs (Positive Energy Districts), with which cities are trying to tackle the climate crisis and dependence on fossil fuels by becoming proactive players in clean energy production themselves, with digitisation underpinning everything to transform a collection of buildings into a smart, self-

sufficient and sustainable energy ecosystem. However, in order to realise this potential fully, there are important issues to be taken into account at the same time: such as citizens' privacy and cybersecurity; the need to invest in infrastructure and training, which are essential to be able to implement the new technologies; and to consider the sustainability of the technology itself, which itself has an environmental impact (production, energy consumption and disposal). It is important to emphasise that "digital sustainability" is not only about the application of technologies, but also the conscious and responsible use of them, to ensure that the benefits outweigh the potential negative impacts on the community.

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