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THINK

POLICY BRIEF

PROMOTING HUMAN-CENTRIC TECHNOLOGIES AND THE URBAN NEXUS TO ADDRESS THE WATER-ENERGY-FOOD (WEF) SUSTAINABILITY CHALLENGES OF SMART CITIES

Task Force 10

SUSTAINABLE ENERGY, WATER, AND FOOD SYSTEMS

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موجز السياسة

تعزيز التقنيات التي تتمحور حول الإنسان والترابط الحضري لمواجهة تحديات استدامة المياه والطاقة والغذاء للمدن الذكية (WEF)

فريق العمل العاشر

نُظم الطاقة المستدامة والمياه والغذاء

المؤلفون

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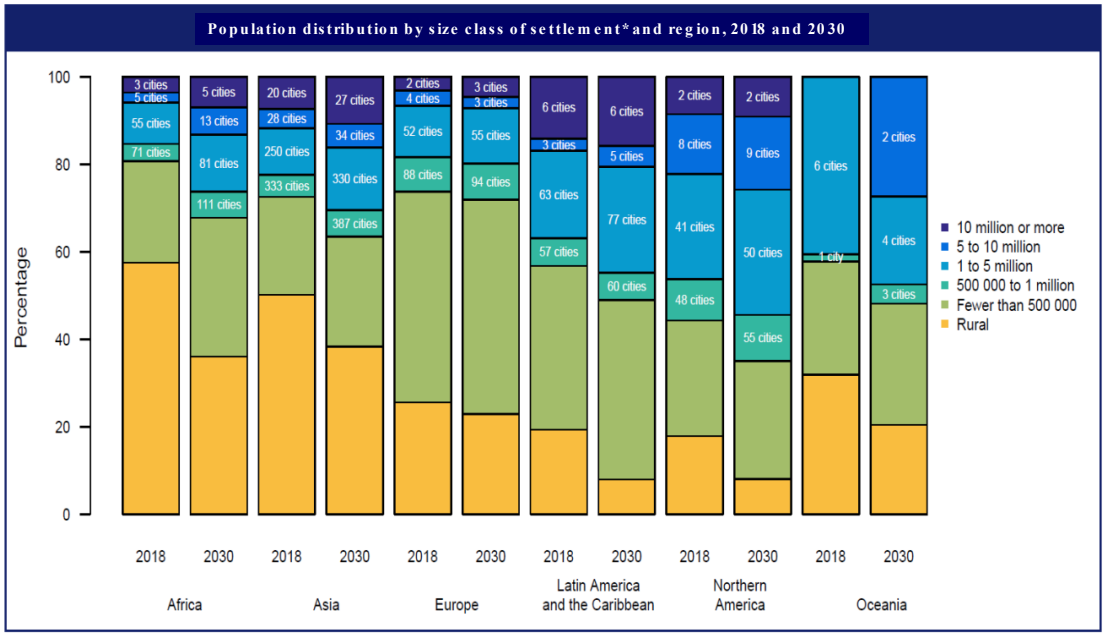
ABSTRACT

This policy brief elaborates on how G20 countries can support the investment and development of digital infrastructure (smart city technologies and the Internet of Things [IoT]) and appropriate institutions. These instruments will be necessary for the success of the urban nexus. They can also improve local democracies as catalysts for local effective and inclusive governance. This policy brief also proposes a corresponding sustainability framework integrating human-centric digital technologies, urban nexus indicators, and decentralized decision making. It discusses the applicability of such a framework in critical cases, such as the COVID-19 pandemic.

يوضح موجز السياسة هذا كيف يمكن لدول مجموعة العشرين دعم الاستثمار وتطوير البنية الأساسية الرقمية (تقنيات المدن الذكية وإنترنت الأشياء [IoT]) والمؤسسات المناسبة. تمثل هذه الأدوات عوامل أساسية لتحقيق النجاح في الترابط الحضري وتحسين الأنظمة الديمقراطية المحلية بصفتها عوامل محفّزة لنظام الحوكمة المحلية الفعَّال والشامل. يستعرض موجز السياسة إطار عمل استدامة مناسب يستند على التقنيات الرقمية المتمحورة حول خدمة الفرد ومؤشرات الترابط الحضري واللامركزية في عمليات صنع القرار وإمكانية تطبيق هذا الإطار في الحالات الحرجة، مثل جائحة فيروس كورونا المستجد (كوفيد ١٩).

CHALLENGE

Currently, more than half of the global population lives in cities, and this share is expected to rise to 70% by 2050 (OECD 2020). Cities have the largest share of concentrated human population in dense urban environments leading to an increasing percentage of large-scale megacities throughout the world. Figure 1 illustrates that this is expected to increase by 30% from 2018 to 2030. Moreover, satellite cities around capital cities are increasing in number and offer better opportunities as smart cities by converting and modernizing the existing infrastructure. Coupled with the rise of the middle class, this extempore urbanization has introduced a steady rise and change in consumption patterns. This has put more pressure on water, energy, and food (WEF) resources, adding to the magnitude of their scarcity that is being witnessed worldwide. This trend has caused a series of discussions worldwide to identify and manage the negative effects. For example, in 2016, 30 mayors of from cities including London, Paris, Sydney, Cape Town, Tokyo, and New York urged governments, ahead of the G20 summit, to take action on climate change and "build a low carbon, climate safe world" (Brittlebank 2016).



*The population of cities with fewer than 500,000 inhabitants is estimated by taking the difference between the total urban population and the population in cities with 500,000 inhabitants or more. The number of cities with fewer than 500,000 inhabitants is not estimated.

Figure 1. **Worldwide Urbanization Trends 2018–2030 (UN 2018).**

The transition to sustainable smart cities can address the challenges mentioned above by facilitating successful technological approaches that will improve the quality of life for residents through an efficient supply of WEF and other services. This involves the development of digital technologies to facilitate efficient smart city services and solutions that will secure WEF supply mechanisms. Effective governance must also be promoted, based on WEF nexus indicators. These indicators should target the smart and integrated management of natural resources, facilitating a collaborative process involving all the relevant stakeholders (OECD 2020).

This approach will guide the key stakeholders collectively to identify and explore potential synergies between industries, technical fields, jurisdictions, and will enhance operational efficiency, optimize resources management, and improve service quality.

To establish sustainable smart cities, critical factors include technologies for digital economies and societies (such as those based on the Internet of Things), effective institutions, and sustainable financing mechanisms. Related success stories that could be highlighted include the Dubai Electricity and Water Authority (DEWA) that has installed smart meters across the Emirate, enabling customers to receive real-time information on water and energy consumption. This smart grid network provides historical data—for optimizing water and energy consumption—to citizens via smartphone applications. This allows them to view billing information, graphs to check and compare consumption, and set caps for both water and electricity consumption (Brears 2016).

Furthermore, the current COVID-19 pandemic outbreak has uncovered many issues and problems that need to be addressed by smart cities and their related technological mechanisms. They must address the negative impacts of such global-scale events on public health, financial stability, accessibility to resources, and every aspect of the citizen's everyday life and prosperity.

PROPOSAL

Policy Recommendations

The policy brief will identify key solutions for addressing the issues related to increasing urbanization affecting the quality of life, as well as resilience against unexpected threats such as COVID-19. The following policy recommendations involve the promotion of emerging digital technologies such as the IoT, Artificial Intelligence (AI), and Big Data. They consider both WEF urban nexus indicators and effective local governance to enable the efficient implementation of smart services for citizens.

1. The implementation of human-centric smart city digital technologies, such as the IoT, with effective and accountable governance frameworks to achieve long-term sustainability and resilience, ensuring WEF supply and security.

We recommend the generation of policies to promote smart city technologies (such as the IoT) in specific fields of WEF to address the requirements of both regular and disruptive events, such as the COVID-19 pandemic. The key motivation is the ongoing effort of countries worldwide to develop fully sustainable regions and cities that will address their citizens' needs at all times. Enhancing cities' everyday services requires the overall digital transformation of their operations. This is achieved not through ad-hoc solutions but through fundamental changes that will have a decisively positive effect on the everyday life of all citizens and promote the quality of their lives substantially. At the same time, user privacy and data security have to be respected to allow for the wide adoption and safe penetration of the developed technologies. Human-centric development is required to transform cities and regions into sustainable areas where citizens and families will freely live, work, enjoy, and create.

Additionally, the G20 has been developing a digital agenda and has identified the IoT as one of the main emerging technologies to address digital transformation challenges (G20 2017; G20 2018). Finally, within the context of the emerging COVID-19 pandemic, the G20 is engaged in enabling the development of suitable systems and methods that fight the spread of the pandemic and enhance the capacities of all countries. There is an appropriate consideration for those with weaker response mechanisms, as is the case for lower income countries (LICs; G20 2020).

We recommend the promotion of infrastructure that enables the sustainable and human-centric growth of the following smart city technologies (Lytras and Visvizi 2018; Talari et al. 2017):

- Internet of Water for measuring the quality of extracted/desalinated water and ensuring its efficient distribution for various uses (home, industry, and agriculture) as well as the use of wastewater for energy, land fertilization, and irrigation. Policies

will be required to enable the deployment of appropriate IoT measurement infrastructure. Policies should also address access to water extraction, desalination, purification, and wastewater management sites for optimizing water distribution, usage, and recycling. This also raises the requirement for infrastructure investments such as wastewater treatment and desalination plants distribution network.

- Internet of Energy: The promotion of IoT infrastructure for real-time energy management (from production to end-user consumption sites). This goes beyond energy distribution to fixed sites, as it will also involve the widespread use of smart grid technologies. These promote energy efficiency, dynamic sharing, and exchange of energy among vehicles and citizens via the availability of public energy charging sites and the development of technologies for charging-on-the-move. New policies will have to be enforced to enable IoT technologies that can contribute to energy transition (use of renewable energies and improve energy efficiency), avoid energy wastage, and enable energy sharing among users. This will optimize the whole production, distribution, and consumption cycle. Again, this requires considerable investments in the supporting infrastructure for energy production, distribution, and smart sharing, and the appropriate deregulation of energy production and distribution.

- Internet of Food: This involves the integration of all stages of food production, distribution, and consumption. This includes smart agriculture, food traceability, and promoting quality of nutrition, which will lead to environment-friendly food sustainability and consequently to human wellness and health. IoT technologies play an important part in this optimization procedure with the widespread use of sensor and actuator networks in all stages of food production. Therefore, appropriate policies need to be generated to enable the interconnection between food producers, distributors, and consumers. Additionally, policies should promote circular economy paradigms in the food sector that will create efficient natural resources recycling and make value out of waste by digitizing the food production and consumption chain.

The smart-city technologies mentioned above should be promoted with principles that respect human privacy and data security. Therefore, appropriate policies should ensure that the generated information (measurements, observations, and metadata) is protected from any privacy and security threats.

Additional policies should enable the following:

- Investment in developing the required wired and wireless infrastructure that can allow the deployment of the required networks (high-speed optical fiber networks, 5G software-defined wireless networks, Big Data Nodes, and massive sensor and actuator networks).

- Support for collaborative research and development collaborations among academia and industry for developing new digital applications and solutions. The motivation of synergies between the state and private sectors by further enabling the formation of public-private partnerships (PPPs) in research and development collaborations and in developing the required infrastructure.

- Selective deregulation on the use of natural resources for generating sustainable energy and water services.

- Establishment of working groups to investigate best practices and develop specific guidelines for the promotion of human-centric IoT and digital technologies for sustainable smart cities.

2. The adoption of urban nexus metrics to deliver on SDGs and the Paris Agreement related to sustainable and digitized city management and effective local governance.

We recommend using nexus metrics and indicators for accounting for progress in resource efficiency and decarbonization in cities. These should also harness the potential of new technologies to review and monitor the nexus integrated approach to achieve SDGs 2, 3, 6, 7, 11, and 13 and urban pledges (NDCs) to the Paris Agreement (Carmona-Moreno et al. 2019). That means using a certain number of indicators that consider water, energy, and food together, and not just one of them, such as the water stress indicator or energy use by desalination plants. This will help in assessing the achievement of the SDGs mentioned above. Such metrics or indicators must be suitable to increase the awareness of policy-makers to the need to govern the WEF nexus more effectively because of problems of convertibility and missing data (Voelker et al. 2019).

The informative WEF nexus indicators are as follows (Arthur et al. 2019):

- Water indicators such as water-consuming rates and patterns, intensities, footprints, and water usage in energy-related procedures.

- Energy indicators such as direct and indirect energy consumption, intensities, and carbon footprints.

- Food indicators such as periodic crop yields, food consumption patterns, and water and energy contributions in the development, distribution, and consumption of food products as well as waste management and recycling.

Additionally, there is a need to support LICs to generate and use WEF nexus data to promote circular economies in city, peri-urban, and rural ecosystems. Another important recommendation is to prioritize cities in access to global climate finance and sustainable development finance pledges in both bilateral and multilateral aid (UN 2019).

It is worth mentioning that poor water infrastructure in cities puts the world at greater risk from the current coronavirus and other similar threats in the future. Decision-makers have to facilitate synergies in infrastructure development, operation, and maintenance. Moreover, the nexus needs to consider the health dimension by building infrastructure that responds to health standards and guidelines (Daher and Mohtar 2015).

This would not be possible without establishing and enforcing accountability/transparency mechanisms for bilateral and multilateral financing dedicated to local government entities and sustainable urban development (Carius and Kramer 2017). These will empower democratic institutions and distribute decision making.

Finally, it is important to ensure climate finance commitments by high income countries (HICs) to allow for predictability and long-term urban planning of WEF nexus investments, loans, and grants. Moreover, we need to harness smart technologies to enhance the capacities of local governments and their boundary partners, including the private sector, bankers, and CSOs, in integrated planning WEF nexus in sustainable smart cities (Hoff et al. 2019).

Several urbanization models incorporate digital technologies to address some of the urbanization and sustainability challenges. Digital cities feature the integration of digital technology into the city's core infrastructure systems. Intelligent cities rely on the digital city infrastructure to build intelligent buildings, transportation systems, schools, enterprises, public spaces, and public services, and also to integrate them into intelligent urban systems. Smart cities deploy intelligent urban systems at the

service of socio-economic development and improving urban quality of life (Ibrahim, El-Zaart, and Adams 2018).

Sustainable smart city initiatives can help overcome the limitations of traditional urban development that tends to manage urban infrastructure systems in silos. They leverage the pervasive character of data and services offered by digital technologies, such as cloud computing, the IoTs, or open data. This helps connect different city stakeholders, improve citizen involvement, offer new and enhance existing services, and provide context-aware views on city operations. Sustainable smart cities are, however, overly complex, challenging, and context-specific. The challenges include different discourses used by technologists and policy-makers, the lack of capacity to connect urban sustainability challenges to actionable approaches, and pressures on social and territorial cohesion requiring unique governance solutions (Bibri and Krogstie 2019).

The policy recommendations mentioned above are also applicable for critical cases or unexpected global scale events such as COVID-19. As Kummitha (2020) discussed, during the pandemic, there was a wide availability and opportunity for using digital technologies (IoT, AI, and Big Data) to assist in the advanced surveillance of areas and persons. They could identify infection patterns and outbreak sites and prioritize locations that should be quarantined. In some cases, this was achieved using a techno-driven approach, where using technological tools was the priority without considering privacy and ethical issues. This approach may have contained the disease successfully but also allowed its initial outbreak as there was full control of the information flow from the very beginning. However, the human-driven approach respects human privacy issues and was based on voluntary crowdsourcing of personal information and anonymizing (wherever possible) the collected data. However, there was no full centralized information flow control and no interoperability among big data systems, leading to inefficient information exploitation and delayed responses in the various stages of the outbreak.

Additionally, there were cases of incorrect news being disseminated and “infodemics,” leading to information disorientation that impeded the crisis response mechanisms. Therefore, it is evident that the emerging digital technologies, accessed data and information, and hierarchical governance that exploits this information play an important role in addressing global-scale events and threats such as the COVID-19 pandemic. They need to be coordinated/intertwined to provide effective results in responding to crises. Therefore, the recommended policies should encourage the development of holistic approaches encompassing advanced digital tools, universally

usable and harmonized data formats, inter-operable databases, compatibility standards among different institutions, local governments, and countries, and the careful use of personal data that respects human rights and privacy regulations. Additionally, they should enable data openness among countries to ensure a rapid response in crisis outbreaks observed in specific areas and avoid worldwide spreading patterns, enhancing local and global resilience.

As mentioned above, there is a need for a holistic framework linking the technologies, governance models, and WEF nexus indicators to address the regular requirements and unexpected threats, as illustrated in Figure 2. For example, in cases such as the COVID-19 pandemic, appropriate measures should be taken to exploit data from different sources. These include:

- Infection rates;
- Localization of infected citizens;
- Resource requirements in terms of services (e.g., health assistance, telemedicine, and intensive care units);
- Resource requirements in terms of WEF (e.g., required energy and water supply, food availability in stores, and critical products such as those related to sanitation to prevent person-person infection); and
- Resource requirements in terms of city- and country-wide traffic management (e.g., for preventing infected citizens' mobility and contact to contain the disease as much as possible).

This framework should allow the efficient sharing and exploitation of big data from different underlying Internet of Everything Systems (e.g., water, energy, food, health, and transportation). The framework should also make use of intelligent decision support systems (i.e., based on AI mechanisms). This will help provide useful solutions to limit the pandemic outbreak and enable efficient resource usage among all citizens.

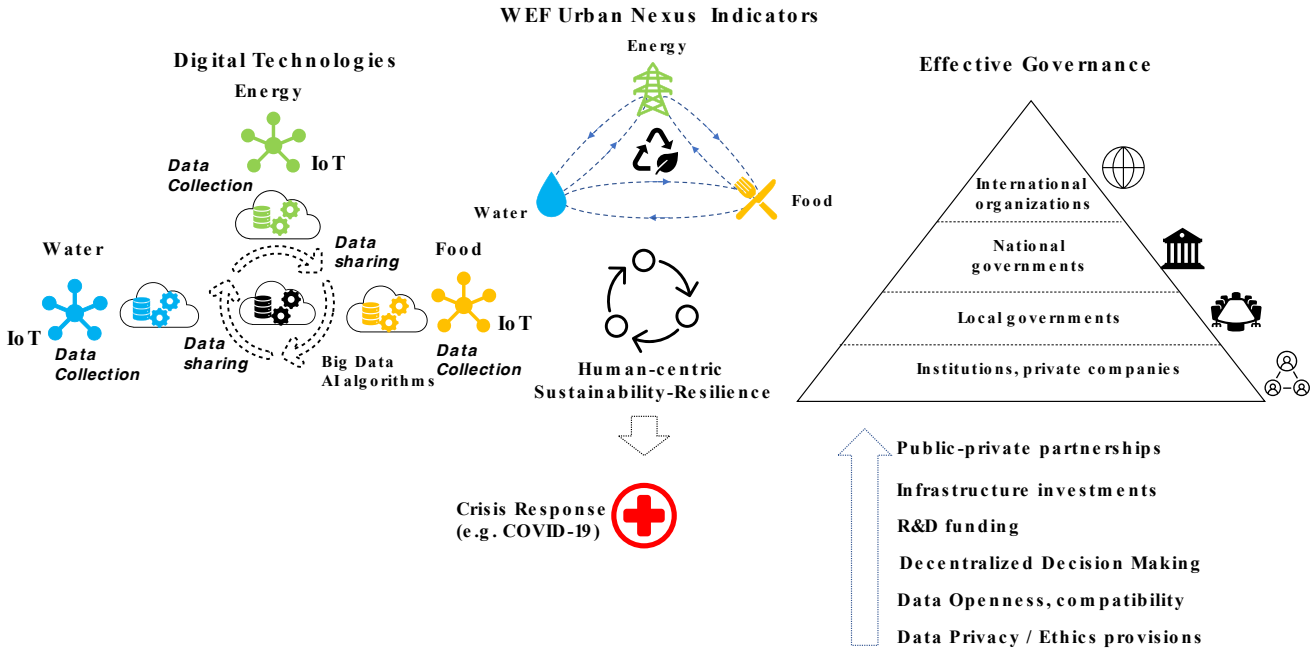


Figure 2. **Holistic human-centric sustainability/resilience framework encompassing digital technologies, WEF nexus, and Effective Governance in smart cities.**

This framework integrates digital technology innovations, WEF urban indicators, and effective governance models to provide a holistic solution promoting resilient cities that can provide safety, health, and sustainability to their citizens, in line with currently discussed trends (Neill 2020).

The G20 can promote the development of such frameworks by motivating the formation of interdisciplinary working groups that focus on human-centric sustainability and resilience solutions within smart cities. These groups should consider effective governance principles and produce valuable best practice guidelines.

Disclaimer

This policy brief was developed and written by the authors and has undergone a peer review process. The views and opinions expressed in this policy brief are those of the authors and do not necessarily reflect the official policy or position of the authors' organizations or the T20 Secretariat.

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