Smart and Circular Cities

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Cities around the world are populated with more than 50% of the increasing worldwide population. In light of climate change, cities' growth poses significant challenges at all levels. Their sustainability requires the participation of all stakeholders.

The world's population has been growing dramatically the last decades, reaching approximately 8 billion people in 2022 and expected to exceed 10 billion before the end of this century, from approximately 2.5 billion in 1950, based on United Nations data.[1] Importantly, a significant portion of people, more than 50%, is attracted to cities and their commuting zones; the 2.1 billion people living in them in 1975 raised to 4.9 billion in 2025, according to the Organisation for Economic Cooperation and Development.[2] This exponential population growth in population of the world's cities accompanied by climate change, which makes natural resources such as water scarcer, leads to a need for a change in the way we build, grow, manage, and govern cities to make them operational, safe, and effective in meeting everyday needs of their inhabitants and, importantly, sustainable.

It has become clear that modern cities need new operational models to achieve these goals, such as models of circular economy, resource management, and infrastructure growth, requiring new models of governance and management. Technology plays a significant role in these directions as it enables automation of processes and effectiveness at different levels, from transportation and communication to health services and supply-chain management. To guarantee that operational processes support day-to-day life, it is imperative for cities to evolve in accordance with specific optimization criteria and meet key performance indicators (KPIs).[3] To measure the evolution of specific urban services and related KPIs, it is necessary to have available technology that enables, more or less, continuous monitoring, both in terms of space and time, of these processes. Due to this, more than a decade ago, novel projects were started,[4] whose objective it was to evaluate the impact of a massive technological deployment on an urban context, not only from the viewpoint of the different urban services and their management but also from the perspective of the citizens themselves, given the possibilities opening up for them.

Many initiatives have appeared, initially in Europe and later worldwide, aimed at bringing digital transformation of different services. Heterogeneous devices, known as the *Internet of Things*, are deployed with multiple purposes. In a parking management application, for example, monitoring the availability of overground parking spaces and reporting it through information boards placed at the crossroads of related streets and through a simple application on drivers' mobile devices enables drivers to find available parking places and the routes to get to them.[5] This achieves a reduction in the delay to find a parking place and leads to a reduction in fuel consumption and related gas emissions. Another application case is the irrigation of parks and gardens, monitoring ground humidity; through deployed sensors, soil humidity, solar radiation, and wind speed can be measured, enabling adjustment or interruption of watering cycles based on current measurements. An increasingly popular and widely adopted application is nonorganic waste management, where sensors measure the occupancy level of garbage containers, for example, through ultrasound technologies, enabling real-time management of the routes of waste collection trucks with the consequent service improvement through reduced fuel consumption and fewer traffic jams.

TO GUARANTEE THAT OPERATIONAL PROCESSES SUPPORT DAY-TO-DAY LIFE, IT IS IMPERATIVE FOR CITIES TO EVOLVE IN ACCORDANCE WITH SPECIFIC OPTIMIZATION CRITERIA AND MEET KEY PERFORMANCE INDICATORS.

Obviously, the term of intelligent or smart city does not come exclusively because of technology deployment; in fact, there are many additional considerations to bear in mind. Citizen participation is especially relevant to the paradigm of a smart city. To achieve this participation, more than the technology deployed, it is fundamental to make diverse services available to citizens based on the needs that they themselves have suggested. Importantly, in addition to the use of services, it is desirable that citizens

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participate actively in conception and even development, if possible. In general, citizens should not need to have knowledge of the technological tools and techniques necessary for these purposes, so it is especially interesting to use intuitive platforms that facilitate and stimulate this cocreative role of the citizens.

Considering more deeply this cocreative and participative role of the citizens, the data generated by them open up a new economy in the urban context, promoting different kinds of transactions and bringing new challenges in terms of data ownership and use by third parties. To respond to these and other challenges, entities such as the data marketplace and technologies such as distributed ledger technology have set themselves up as fundamental pillars for supporting the emerging urban economies. Artificial intelligence, enabling the cities running in optimal conditions with minimum human intervention, as well as security and safety, are additional components that will enable making the paradigm of more efficient, sustainable, resilient, and livable cities a reality.

Supporting this vision, eight articles dealing with smart and circular cities have been selected for this special issue. The first one, "Redefining Circular Cities: Regulation, Governance, Infrastructure, and Technology," provides a perspective on the main challenges that the cities will cope with and the different regulations to which they will be subjected, demonstrating the need for addressing all aspects, from governance to technology. The second article, "Edge Computing: The Computing Infrastructure for the Smart Megacities of the Future," relies on several use cases to postulate the use of edge computing architectures to fulfill the requirements of future megacities. The third contribution, "Federated Cyberattack Detection for Internet of Things-Enabled Smart Cities," demonstrates how emerging technologies like artificial intelligence and federated learning enhance security and safety by identifying cyberattacks while protecting citizen privacy. "Smart City Intersections: Intelligence Nodes for Future Metropolises" presents an experimental study carried out in smart city intersections, aiming at increasing traffic and citizen safety. The fifth article, "Interoperable Internet of Things for Smart Transportation Systems in Circular Cities," shows how Internet of Things heterogeneity barriers can be overcome, fostering information exchange among different smart city components, while the subsequent article, "Usage Mining of the London Santander Bike-Sharing System," analyzes and models bike-sharing systems relying on a huge dataset analysis that enables one to identify different behaviors in terms of trip patterns. The seventh article, "Overcoming the Barriers of Using Linked Open Data in Smart City Applications," proposes a set of scalable tools for overcoming the existing barriers related to open data in an urban context, which are assessed in a public-rental

bike system. The final article, "Business Model Canvas for Big and Open Linked Data in Smart and Circular Cities: Findings From Europe," proposes a Canvas business model for linked open data in the context of smart and circular cities, opening possibilities for the approach for a wide range of applications and services targeting effectiveness and sustainability.

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