Global Future Council
on Cities and Urbanization

WORLD
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Smart at Scale:
Cities to Watch
25 Case Studies

COMMUNITY PAPER

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① Foreword

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Ever since humans started living together in large numbers, the city has been a critical site for social experimentation. Medieval Italian city states, such as Venice and Genoa, were critical experiments in the history of democracy, while the phalansteries proposed in 19th-century France by the philosopher Charles Fourier brought forward the then-radical ideas of minimum wages and women's rights. In the 1980s, a "special economic zone" in Shenzhen, China, acted as a catalyst for a historic economic boom.

Urban innovation is particularly necessary today, as the internet of things is spearheading a new wave of experimentation. We are entering the era of smart cities, in which information and communication technologies capture extraordinary amounts of data and deploy their findings, often in real time, to transform city economies, social cohesion and city governance. We must therefore try different approaches, from both the public and private sectors, to best incorporate these technological advancements into our lives and test their pros and cons.

This paper was conceived and developed last year, just before COVID-19 disrupted even our most ingrained daily habits: moving freely across one's city, catching a train or a flight with very little planning, sharing close space with strangers in a restaurant, an office or a square. Several months into the first outbreak of the pandemic, we were able to understand much better how our physical lives are intertwined. This lesson, which we learned the hard way, must now be leveraged so we can develop new tools to improve our urban experience. Precisely because of the unprecedented scale of the events of early 2020, the case studies listed in this document have become even more relevant. The cities in this paper – their leaders, public officials, administrators, businesses, universities and communities – have taken extraordinary steps to render the urban environment more inclusive, equitable, agile, open to new ideas and, ultimately, resilient.

The fundamental purpose of this publication is to inspire us in committing to even more experiments for urban innovation. Without a doubt, some efforts will work better than others, will go to scale and will be adapted and adopted by other cities, which is why it is so important to explore novel ideas in a broad range of fields affecting our everyday lives. We hope these case studies will help advance the conversation and offer useful insights for our common urban future.

② Introduction

The World Economic Forum Global Future Council on Cities and Urbanization has leveraged its knowledge, networks and the public to identify 25 leading smart city projects that have successfully moved beyond the pilot stage. The Council created a platform on the Forum's website to allow the public to submit their case studies and asked all Council members to advise their networks and spread the word through their social media platforms.

These projects have leveraged critical success factors to move smart, sustainable and innovative initiatives to scale, including the following:

– Public-private cooperation

– Ambitious and strategic actions to meet commitments of the Paris Agreement on climate change, the Sustainable Development Goals and the New Urban Agenda

– An innovative or future-oriented focus

– Scalability and a proven positive impact on social, environmental and economic aspects of the city

– Agile and smart governance, policy, technology, business models and financing

– Significant leadership and credibility with respect to the local context

3 What is a smart city?

Definitions of a smart city and its parameters abound and are often used in different ways that stress one or another of its facets. What is common, however, is the use of new technologies to find efficient and affordable solutions to urban challenges (see Cocchia, Annalisa, "Smart and Digital City: A Systematic Literature Review", in Renata Paola Dameri and Camille Rosenthal-Sabroux (eds), *Smart City: How to Create Public and Economic Value with High Technology in Urban Space*, Progress in IS, Springer International Publishing Switzerland, 2014, pp. 13-43).

More precisely, the internet is entering physical space and becoming an internet of things (IoT), ushering in a series of unprecedented possibilities. When dealing with production, this phenomenon is usually referred to as the Fourth Industrial Revolution; when it concerns urbanization, people prefer the term "smart city", although both terms are sometimes used interchangeably.

A smart city project generally has certain key components, based on the collection, processing and interpretation of data used to transform some aspects of the city – something that can be called "actuation". Such feedback loops based on sensing and actuating are not unlike those found in living systems, for instance in the interaction between people.

Clearly, big data analytics, artificial intelligence (AI) or other systems are an important part of a smart city. Equally important is connectivity, driven by the ubiquity of mobile cellular subscriptions (7.86 billion worldwide in 2018, according to World Bank Open Data) and 3G, 4G and even 5G networks, with 70% of the world's population having access to a 3G broadband network.

4 What problems do smart city applications solve?

Smart city applications are manifold and can address diverse yet similar challenges that cities face around the world. These include congestion, burgeoning populations, gaps in infrastructure, inadequate service delivery, exclusion, poverty, a lack of competitiveness, limited liveability, vulnerability to climate change, and natural and man-made disasters. In some cases, especially in emerging countries, challenges are even greater and affect the very survival of some of these cities.

Cities are increasingly implementing projects with smart solutions in waste management, traffic congestion, citizen safety, affordable housing, water resource management, smart buildings, efficient use of energy, renewable energy resources, facilitating navigation of autonomous vehicles, citizen participation and stakeholder consultation, to name a few. The Fourth Industrial Revolution is helping cities leapfrog certain stages of development by harnessing affordable digital solutions.

Among these diverse definitions and solutions, the common goals or themes of efficiency, innovation, inclusion and resilience stand out. According to the G20 2019 Japan report *Finding New Solutions through Building Smart Cities*, a city that uses data and digital technologies effectively to plan and manage its core functions becomes efficient, innovative, inclusive and resilient. Integrating digital technologies, especially AI, into a city's systems and services presents new and affordable opportunities for a city to solve its challenges. This in turn will help it achieve the Sustainable Development Goals through efficient use of its resources, effective stakeholder engagement, informed decision-making and better governance.

⑤ Case studies

Given the diverse applications of city "smartness", this paper compiles examples of successful smart city solutions in the following key themes: governance and policy, society, infrastructure and services, environment, and business and economy (see Table 1).

TABLE 1 | **Key themes and issues of successful smart city solutions**

Theme	Governance and Policy	Society	Infrastructure & Services		Environment	Business & Economy
Issues	1. Urban Planning	1. Public Safety and Security	1. Water	2. Waste	1. Air Pollution Prevention	1. Urban Business Environment
	2. City Operations and Finance	2. Health Provision	3. Mobility, Transport and Geographic Accessibility		2. Land Protection and Rehabilitation	2. Private-Sector Investment
	3. Citizen Engagement	3. Access Usage and Completion of Education	4. ICT Connectivity		3. Water Protection and Rehabilitation	3. Development of a Competitive Economy
		4. Social Inclusion	5. Energy	6. Real Estate	4. Biodiversity Protection and Rehabilitation	4. Green Growth
		5. Demographic Change	7. Education, Health, Social, Community & Recreational		5. Urban Resilience and Adaptation to Climate Change	

Case studies from cities around the world were collated for each theme, including cities that successfully implemented projects and expanded them beyond the pilot stage. These examples include projects that have leveraged leading innovations and technology and show cities that have done more with less by maximizing use of resources to meet the needs of their citizens, the environment and the economy.

Each case study was selected based on the following criteria. Namely, the project:

– Can be replicated by other cities, within each city's context

– Is self-sustaining and has successfully progressed from a pilot to a scaling stage

– Identifies costs and benefits clearly, and those that can be monetized

– Is a disruptive solution with a clear outcome.

While not all these criteria are measurable, the focus has been on examples that successfully transformed from a pilot project and that present sustainable, scalable and replicable solutions to specific city challenges.

Theme: | Governance and policy

Urban planning; city operations and finance; citizen engagement

Cities deliver public services, engage citizens and address local urban challenges. Good city governance provides an inclusive platform to allow citizens to strive socially and economically. The intermediary role of city governance is to closely align the increasingly complex needs of its citizens to the public-policy-making process at the national level, which in return allocates public funds to support locally tailored solutions. Cities strive to become functional and provide services of adequate quality, such as transport and housing, in the most cost-efficient way. For most governments, the goal of cost-efficiency can be better achieved with a certain degree of local fiscal autonomy.

Smart technologies unlock exciting opportunities for local governments to become more transparent, accounting and efficient in delivering services. Local governments explore innovative citizen-centred models and leverage big data and AI to scale up their solutions. From urban planning, city finance and citizen engagement, smart technologies gradually shape a new open urban governance, where citizens are more informed and motivated to participate at the neighbourhood level in their city.

CASE STUDY 1	Smart Dubai Happiness Meter – Dubai, United Arab Emirates (UAE)
What	The Smart Dubai Happiness Meter is a simple yet very powerful live sentiment capture tool, implemented to measure happiness among city experiences across thousands of touchpoints.
Why	The Happiness Meter is directly linked to Dubai's vision of becoming the happiest city on earth (Dubai's Happiness Agenda) and is one of the real-time citywide uniform measurement tools to support Dubai's City Transformation Agenda.
How	All high-level city officials endorsed the Happiness Meter, including the Ruler of Dubai. It captures customer happiness information at the city level in a consolidated dashboard. A governing body was established along with an implementation and city experiences enhancement policy. Technology was deployed on a citywide scale, and design was intentionally kept simple to ensure happiness measurements from different sectors, including public services, mobility, energy, environment and social services. The intention is to extend it to the private sector in due course.
Scale	Implemented in phases, the tool was first piloted in a few government entities and subsequently rolled out extensively to 172 public- and private-sector entities in all customer interaction channels (websites, mobile apps, physical service centres) within a year, leveraging co-creation with actual users. More than 22 million Happiness votes from 4,400 touchpoints over 172 entities were collected in two and a half years.

CASE STUDY 2 | **Urban Environment Quality Index – Russian Federation**

What | The Urban Environment Quality Index is a regular monitoring tool. Its indicators evaluate the quality of city infrastructure, determine the popularity of parks in the city or the attractiveness of streets to pedestrians, and identify those spaces in the city most in need of improvement. The Urban Environment Quality Assessment is done across more than 1,000 cities, which are diverse in both size and climate in the Russian Federation.

Why | The Housing and Urban Environment programme, launched by the Russian government in 2018, aims to increase the Index scores by 30% for over 1,000 cities and reduce the number of uncomfortable cities in the country by 2024. The scale of the programme is unprecedented. To systematically prioritize projects at a national level and to ensure a consistent evaluation standard on the effects of project implementation for over 1,000 cities, the Index is a necessary tool to support the annual assessment of quality and the condition of those urban environments.

How | The three-year programme has included development of the evaluation model up to the approval of methodology at the national level, during which an innovative principal model – the first of its kind – was developed based on the city morphology. An evaluation of 1,112 cities was conducted, together with additional studies of several cities to further verify the model and enable a public discussion among experts to review and improve the methodology.

Scale | The expert technique, first tested in 20 cities during the pilot stage, was later adopted by one of the ministries. Eventually it became a national tool for assessing the quality of the urban environment for each city and has been widely used by the government, mayors, entrepreneurs and individual citizens.
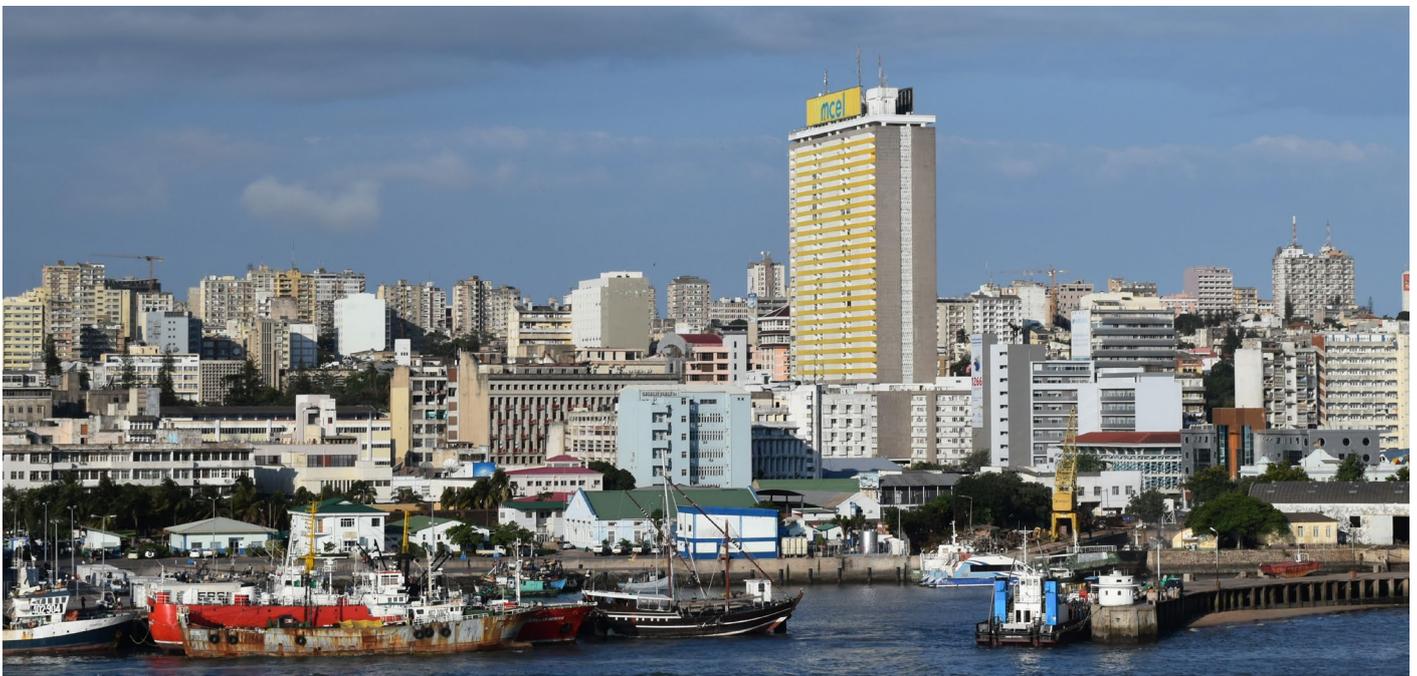
CASE STUDY 3	**Open Data Roadmap – Maputo, Mozambique**
What	The mayor of Maputo launched the Open Data Roadmap initiative to improve transparency and accountability through open data. Maputo, the capital city of Mozambique, is relatively small and early in its growth trajectory compared to other African cities. A grid network and several robust urban planning initiatives in the downtown area have laid good foundations for a well-planned city. However, nearly 75% of the city's population lives in informal settlements.
Why	Land records are vital for addressing inclusion of the poor in good urban planning practices around informal settlements. Property ownership allows dwellers to use their lands or houses as assets. The lack of clear land titling to individuals and ownership raises the risk the private sector faces in public-private partnerships (PPPs) and private-sector investments. The lack of land entitlement further constrains the use of land as financial leverage for basic urban infrastructure and for attracting private investments, resulting in low revenues generated for the city.
How	Supported by the World Bank, the city successfully held the OpenDataton Hackathon in 2017 to initiate an ecosystem of data producers and consumers, involving stakeholders ranging from banks, individuals and universities to incubators and software development associations. Several apps have been developed towards a more citizen-centred, data-driven and transparent governance. The SISCod app helps to reduce the risk of disputes over land titles by making land records held by the municipality more accessible. Another app, Imp+, allows city taxes to be collected electronically to minimize corruption and arbitrariness.
Scale	This is a simple use of digital capacity for e-governance and urban planning, for attracting private investments to provide basic urban services and for investments in manufacturing and other industries. The Open Data Roadmap initiative is being scaled up in Mozambique to include other cities and rural communities.

CASE STUDY 4	Reinventing Paris – France

What

Since 2014, Paris has been organizing an initiative to reinvent its urban mode of production. Within the city's urban fabrics, projects emerged from a model that blends in the debate between heritage and cultural preservation and the urgent 21st-century issues facing the city, such as density, sustainability and urban resilience. With Réinventer Paris (Reinventing Paris), Réinventer la Seine (Reinventing the River Seine), Reinventing Cities and Inventons la Métropole du Grand Paris (Inventing the Greater Paris Metropolis), innovative reinventions contribute to modernizing Paris without changing its core sociocultural characteristics.

Why

The selected sites, often abandoned or underused facilities, required an innovative real estate development approach with ambitious sustainability targets.

How

Paris called for talent internationally to respond to two rounds of innovative urban projects under Reinventing Paris. The first round, launched in 2014, attracted 372 project submissions for 23 sites, with 21 winning projects delivered or under construction since 2016. All projects were developed and evaluated by international and multidisciplinary teams that brought together architects, city planners, real estate developers, artists, start-ups, designers, landscape architects and civil society associations.

Scale

Building on the momentum and success of the first round, the second round of Reinventing Paris was launched in 2017, with 22 projects chosen from more than 200 submissions. Among them were innovative business models and programmes focused on the city's underground spaces.

Inspired by the success of Paris, the C40 Cities Climate Leadership Group launched a global edition of Reinventing Cities in 2018 in 12 cities around the world with 31 underutilized spaces.

| CASE STUDY 5	New Urban Mechanics – Boston, USA
What	New Urban Mechanics is a civic innovation group embedded within the City of Boston's government.
Why	The objective is to inject human-centred design within government and create a template for civic innovation across the country.
How	The New Urban Mechanics team works across different sectors, such as education, housing, streets, innovative public space and civic research. For example, they improved the school registering process from a paper-based format to an online platform where parents could explore different school options and compare them side by side. They built a tool called DiscoverBPS that allowed parents to have that an easier, more pleasant kind of digital experience than perhaps they had had otherwise. The New Urban Mechanics team launched Community Made, a civic crowdfunding platform, to encourage Boston citizens to imagine a collective space they desired, thus creating a bottom-up approach to fostering social cohesion and resilience.
Scale	The New Urban Mechanics model has been replicated in the United States in the City of Philadelphia and the State of Utah.

Theme: Society

Public safety and security; health provision; access usage and completion of education; social inclusion; demographic change

A city offers many social services to its residents, from education to healthcare and safety. How functional a city is can be assessed by its capacity to respond to rapid demographic changes and to provide social services in tandem with an expanding population. In addition, ageing populations affect the mobility of urban populations and raise societal challenges requiring an inclusive response. How a city can leverage digital transformation to make urban services more accessible and user-friendly for the elderly, the disabled, women, children, ethnic minorities, the poor and vulnerable is just as important as how to make a city more comfortable to live in.

Cities around the world strive to deliver the social services citizens need and to create an urban environment that is not only comfortable, healthy and safe, but also enables citizens to thrive. Cities often adopt a human-centred approach to integrate smart technologies and innovative models into urban systems to deliver quality social services that meet individuals' needs. In addition to new service models, cities leverage opportunities to maximize social impacts and benefits within urban developments.
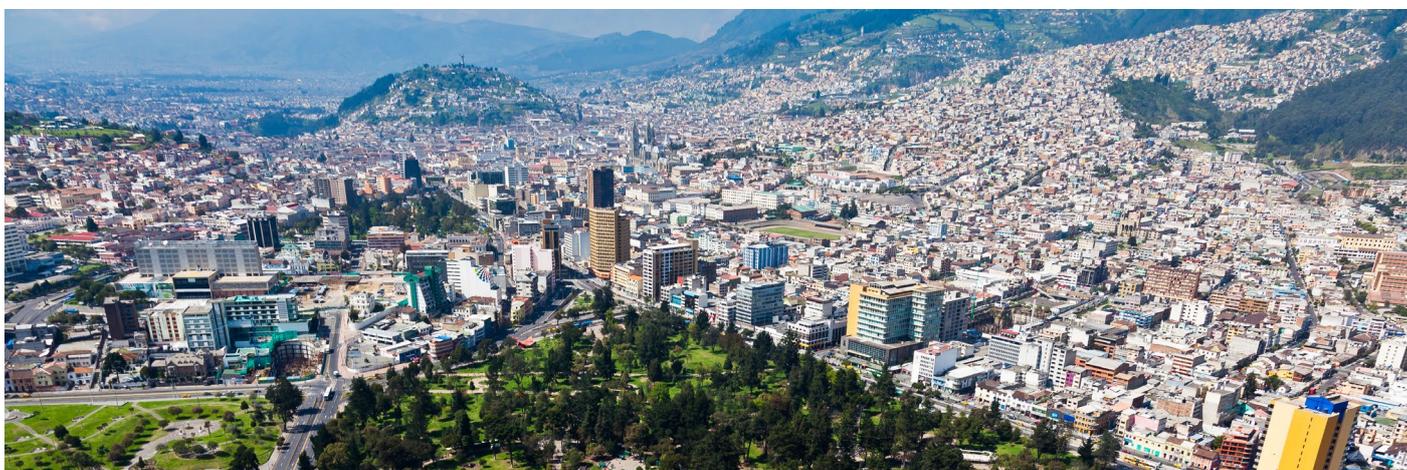
CASE STUDY 6	Bájale al Acoso (Turn Down Harassment) – Quito, Ecuador
What	Bájale al Acoso, implemented in Quito, aims to fight sexual harassment in the public transport system through instant reporting via SMS text messages.
Why	The challenge was to tackle sexual harassment issues on public transport and lead a dynamic cultural change to create a safe and inclusive public transit system. In 2014, Quito developed protocols to educate municipal civil servants on how to approach situations of sexual violence. After the 2016 declaration to join the UN Women's Safe Cities Global Initiative, the Municipality of Quito developed action plans and, led by an interdisciplinary team, implemented Bájale al Acoso.
How	An immediate response by a team of psychologists, social workers and lawyers was designed. The project was piloted on municipal buses and then implemented on all public transport systems. In two years, 2,800 cases of sexual harassment were reported, and 73 perpetrators were prosecuted after legal suits.
Scale	Besides the legal punishment against harassers as derived from Bájale al Acoso, the strategy has raised a broader public awareness of gender violence and the need to create a safer environment for women. The momentum generated is contributing to building a more equal and inclusive society to empower women. Buenos Aires (Argentina) and other cities are replicating this project.

CASE STUDY 7	**Estaciones Saludables (Health Stations) – Buenos Aires, Argentina**
What	Estaciones Saludables is a programme to promote a healthy diet and living habits to prevent obesity, malnutrition and other chronic diseases caused by an unhealthy lifestyle among citizens in Buenos Aires. The stations are located around main parks and squares with varied timetables to make the healthy habits consultancy services accessible to residents in all neighbourhoods.
Why	Non-communicable diseases, including obesity, diabetes, high blood pressure and high cholesterol, account for three-quarters of deaths in Argentina.
	Smoking, excessive alcohol consumption, bad nutrition (insufficient intake of vegetables) and a lack of physical exercise are the main risk factors leading to diabetes, heart disease, cancer, lung and kidney diseases. These disease are preventable; by eliminating the main risk factors, 80% of heart diseases, strokes and type-2 diabetes, as well as 40% of cancers, could be avoided.
How	The Health Stations programme is part of the larger public health initiative, Desarrollo Saludable (Health Development), launched by the City of Buenos Aires to promote healthy habits and detect risk factors, such as physical inactivity, poor diet and tobacco use through training, consulting on health, and events.
	Many activities have been organized around the Healthy Stations to engage different age groups to participate in healthy living movements. Initiatives for food and sports are encouraged with free services, such as using Healthy Stations free of charge to celebrate Healthy Birthdays for children under 12 years of age, and sports gear can be rented for free through Puro Movimiento (Pure Movement).
	Since 2014, Despertar Saludable (Healthy Awareness) programmes have organized around Healthy Stations on the weekends for the elderly with free sports activities, games, dancing and cognitive workshops for memory exercises.
	Thematic nutrition talks on seasonal fruits and vegetables were planned for the month of March.
Scale	Launched in 2012, the programme has reached more than 1.2 million people, providing more than 5.5 million health consultancy services. All programmes under the Health Development umbrella have been run in a cost-effective manner.

CASE STUDY 8	**Harnessing City Data – Singapore**
What	Singapore has been harnessing data to enhance services and create economic value by leveraging a combination of government and private-sector data in a citywide data platform.
Why	This effort supports better decision-making and planning in six pilots, including health. Singapore's growing elderly population requires services to support independent living and quality care.
How	ConnectedLife's home monitoring solution provides insights to health providers, the insurance industry and government. The solution combines smart technology (IoT, such as motion and sound sensors, data analytics and AI), 24/7 personal assistance and customized insurance coverage from the insurance provider Aviva. It provides caregivers with real-time information and insurance companies with better data, and allows families to protect their elderly members. The solution was developed using DEX, a decentralized citywide data exchange which combines private- and public-sector data.
Scale	Other cities, such as Amsterdam, Barcelona, Copenhagen, Dubai, London and New York, are also combining private-sector data sets with government data to enhance services and create economic value. Innovative cities are creating citywide data platforms to provide data sets to develop practical use cases for analytics and AI applications.

CASE STUDY 9	Hush City Mobile Lab – Berlin, Germany
What	The Municipality of Berlin and the Hush City Mobile Lab developed a free mobile app that helps citizens find quiet areas in their neighbourhoods.
Why	The project addresses an open issue at the European policy level with the impact on science, policy planning, public health, economics, the environment and society. Traffic noise is the second most harmful environmental stressor in Europe, despite being overlooked in the public health agenda; excessive exposure to noise constitutes a health risk, resulting in a high cost to society.
How	The Hush City app can crowdsource the identification of quiet spots and categorize them according to sound level, descriptors, visual quality and accessibility.
Scale	As of 31 January 2019, more than 300 users from around the world had crowdsourced over 1,400 quiet areas. In Berlin, as of 27 September 2018, 169 quiet areas had been crowdsourced by 73 participants. This result led to the exploitation of the Hush City app and related data by the Municipality of Berlin for the Berlin Noise Action Plan.

CASE STUDY 10 | **CareTech – Fukuoka, Japan**

What	Fukuoka has established a collaborative effort involving the local community and IoT networks to monitor and protect the elderly and people who suffer from dementia.
Why	Japan has a rapidly ageing population. By 2025, an estimated 100,000 elderly people will require long-term care, with half of them suffering from dementia. Therefore, it is essential to create an efficient and sustainable scheme that uses new technology and the local community to ensure the elderly population, and especially those with dementia, can comfortably and safely live in the areas they know.
How	Under Fukuoka's [100 Actions to Achieve a Healthy Social Model Anticipating the Era of 100 Years of Life](#) (2017), a systematic dementia care model was developed to safeguard the elderly with dementia by leveraging family members and caregivers, among others, in the 150 neighbourhood communities.
	On the one hand, the city joined forces with various service providers, such as electricians, gas or water providers, newspaper deliverers and postal workers, to check on individual residents at their homes. On the other, door-to-door visits were integrated and assisted by "Care-Tech" solutions, an innovative system that includes daily check-ups, calls and text messages, as well as the use of information and communications technology (ICT) to search for seniors who get lost, and various IoT-based monitoring solutions. For example, LoRaWan is a wide-area, low-energy network that allows families or care providers of people with dementia to track via small GPS devices kept on their person.
Scale	The monitoring schemes started using ICT four years ago, and the systematic dementia care, along with other care programmes for the elderly, has continued to grow under the strategic plan.
	The Fukuoka Health Lab engages citizens, universities, the private sector and administrative offices to undertake research and to develop and implement effective care solutions. The CareTech programme highlights the start-up ecosystem that promotes innovation in healthcare, medical care and nursing care, and the Care-Tech Alliance promotes commercialization of innovative tech solutions through a network of start-ups, companies, medical and nursing care providers, investors and citizens.

Theme: | Infrastructure and services

Water; waste; mobility, transport and geographic accessibility; ICT connectivity; energy; real estate; education, health, social, community and recreational

Urban infrastructure lays a city's physical foundation for daily life: from public utilities that provide all basic services to waste management systems that keep cities clean and transit networks that connect people and places.

The Fourth Industrial Revolution has enabled city infrastructure to be provided in a more smart and efficient manner. For example, a smart building controls the internal environment through an energy-efficient management system that adjusts to the real-time environment from data captured by IoT; or, a public transit optimization system schedules bus routes to meet peak demand or reduce traffic congestion by using road space more efficiently throughout the day. The solutions are not only digital but also include repurposing spaces and re-designing and upcycling infrastructure.

CASE STUDY 11	Copenhagen Cycling Infrastructure – Copenhagen, Denmark
What	Copenhagen is a world leader in providing cycling infrastructure, with more than 450 kilometres of cycle lanes used by 36,000 cyclists every day.
Why	Cycling offers enormous advantages in urban transport, including reduction of congestion, improved air quality, enhanced physical activity and fewer car crashes, with the last three representing substantial public health benefits.
How	In 2007, the City of Copenhagen introduced "Eco-Metropolis. Our vision for Copenhagen 2015", which had three out of 11 goals related to cycling. One was that the city should aim to achieve a 50% bicycle share in commuting to workplaces and educational institutions by 2015. The other two goals related to reducing accidents by 50% and reducing the number of those killed and seriously injured. An intense political focus on cycling issues developed in the following years, with the city delivering cycle infrastructure through the Cycle Secretariat. This resulted in: – **Infrastructure**: A connected network of 2.2-metre-wide cycle paths on each side of city streets, between sidewalks and cars; additional features include coordinated traffic signals ("green wave") and footrests at traffic lights – **Iconic features**: For example, the above-ground Cykelslangen (Cycle Snake) – **Change of culture**: Normalizing cycling for all ages and social groups using strategies such as Copenhagen's Cycle Chic blog
Scale	The Cycling Embassy of Denmark promotes Danish pro-cycling strategies. This in turn has helped promote the use of Copenhagen's strategies in cities across Europe and the world.

CASE STUDY 12	**Santa Monica's Wellbeing Project** – California, USA
What	Understanding that economic growth alone does not truly represent a community's strength or success, the City of Santa Monica is harnessing the power of data to evaluate well-being.
Why	The Wellbeing Project aims to provide advantages to residents through extensive data collection and analysis to better understand the community's strengths and needs. Findings are incorporated into future planning and budget allocation to make the city a healthier and better place to live. The process is dynamic. The city measures well-being on a continuous basis, and the Santa Monica government seeks to build a streamlined system to determine more quickly, more precisely and in a more cost-effective manner what will make Santa Monica thrive.
How	The project gathers multiple data from the city, a widespread resident survey and social media to measure and track citizens' welfare. The Wellbeing Index, a tool that measures well-being in the community, is at the centre of the project. The Index provides a starting point to understand what contributes to well-being and how the city and community can improve it. The project encourages collaboration and broad buy-in among city leaders and local organizations (e.g. needed to convince city government departments to improve their data collection).
Scale	The project was backed by a $1 million grant from Bloomberg Philanthropies. Predicting that measuring well-being will be the "next big thing" in governance, the City of Santa Monica has designed a guidebook specifically to help other cities adopt a well-being index of their own.

CASE STUDY 13	Urban Solar – Singapore
What	With a lack of space and one of the highest population densities in the world, Singapore is pushing to develop solar technologies (solar photovoltaic [PV] systems) suited for cities, known as "urban solar".
Why	Singapore's lack of space means the city can essentially only install solar panels on building rooftops. Roof-mounted PV panels are standard practice, but adding them to building facades causes issues due to building regulations and lower irradiance reaching the vertical parts of a building. The Solar Energy Research Institute of Singapore (SERIS) is therefore working on developing high-efficiency, light-weight solar technologies.
How	The Economic Development Board (EDB) called for investment in research projects that investigate transforming vertical building facades into surfaces that maximize energy production, whether through coatings or cladding. SERIS established a Centre of Excellence for Building Integrated Photovoltaic (BIPV) to develop new solutions and raise awareness in the local building and construction community. In 2016, SERIS, EDB and the Public Utilities Board (PUB), Singapore's national water agency, commissioned the world's largest floating photovoltaic test bed at Tengeh reservoir in Singapore. PUB called for tenders to investigate the effects of large floating solar systems on the country's reservoirs. Taking advantage of its financing ecosystem, Singapore has explored new ways to finance solar projects, such as issuing solar energy green bonds.
Scale	Singapore has been on the journey to scale urban solar energy for the past decade, as the city believes solar constitutes its most promising renewable energy for generating electricity. In this regard, Singapore has been leveraging building facades that can generate electricity from the sun, movable solar systems and floating solar energy plants. It looks set to continue this journey, having set a target of 2 gigawatt-peak of installed urban solar capacity by 2030.

CASE STUDY 14 | **1200 Buildings Program – Melbourne, Australia**

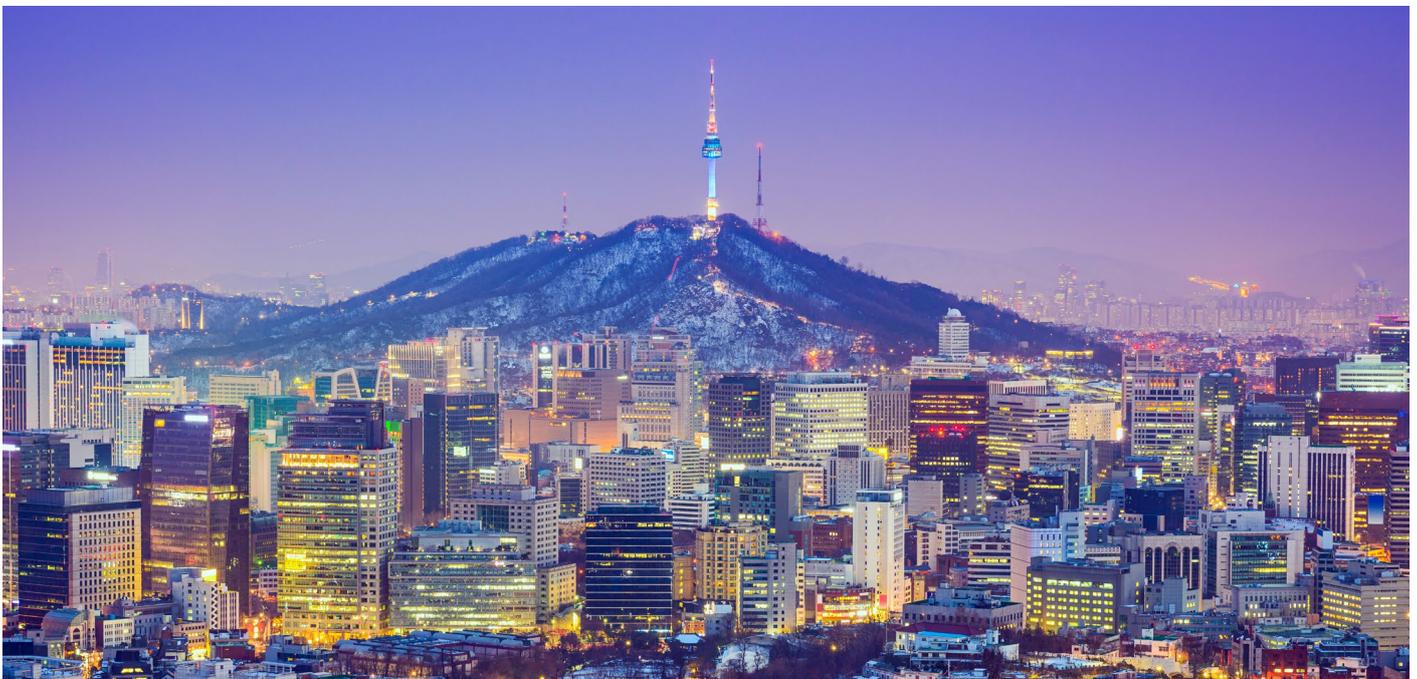|	
What	The city of Melbourne's Sustainable Melbourne Fund (SMF), which administers the environmental upgrade finance mechanism of the city's 1200 Buildings Program, provides low-cost financing for commercial office buildings.
Why	Commercial buildings account for 66% of greenhouse gas emissions in Melbourne, with offices accounting for most of these buildings. While many new office buildings are being built to higher environmental standards, a large pool of existing commercial buildings are inefficient. Research in 2008 showed that if two-thirds of the city's commercial office buildings were retrofitted to achieve better energy performance, the city would get an economic uplift of $2 billion and create 8,000 green jobs.
How	When the city's 1200 Buildings Program was initiated in 2010, an identified lack of understanding about the benefits of energy and water efficiency upgrades existed among building owners and industry. The Program provided online information in the form of case studies and webinars, along with face-to-face seminars and workshops led by industry experts. It further provided access to incentives and government grants to help building owners, managers and consultants to fund energy and water efficiency projects. One significant barrier preventing property owners from upgrading their buildings was access to low-interest finance.

To assist in overcoming this, the City of Melbourne developed a new financing mechanism and established the SMF to administer it. Environmental upgrade agreements (EUAs) are a tripartite arrangement between a commercial building owner, a bank and the local government. Through EUAs, building owners lend money to upgrade their buildings, either from a bank or directly through the SMF as a financier, and then repay the loan via a new statutory charge attached to their building rates. This mechanism uses the existing facility available to the local government of being the first to claim against the property should it default or go into receivership.

This facility was originally put in place to ensure any outstanding rates were settled ahead of any other claims against the property. The local government then agreed with the banks that if they lent money for environmental upgrades, they would use this facility to ensure repayment ahead of any other financial arrangements. On this basis, the banks were prepared to give very favourable rates to building owners for upgrades. |
| **Scale** | The 1200 Buildings Program supported the market to develop the demand for energy efficiency services. The SMF has worked to open the Environmental Upgrade Agreement (EUA) marketplace across Victoria. As a result, more than 30 councils now offer EUAs to their communities. Since August 2016, investment via EUAs has doubled each year through these efforts; over 5.4 megawatts of solar has been installed across 60 businesses, with over $17.2 million in investment occurring. The projects lead to a reduction of 18,000 tonnes of greenhouse gas emissions annually. |

CASE STUDY 15	**Smart Seoul – South Korea**
What	Seoul, with a population of about 10 million, has been ranked 1st in the United Nations E-Government survey since 2003. Smart Seoul Infrastructure refers to the functional ICT framework essential for Smart Seoul services. Smart Seoul builds on the city's previous initiatives of u-Seoul, which focused on efficient service provision, infrastructure and network maintenance, such as water pipe leaks, power lines and efficient public transport route management and safety of riders. Smart Seoul centres on the city's relationship with citizens and aims to improve their quality of life by being more people- and human-centric.
Why	With the Fourth Industrial Revolution, wide availability of the intranet and disruption in digital technology, Smart Seoul's approach was used by the metropolitan government to apply IoT and digital access to focus on its citizen's quality of life and make the city more sustainable, liveable and competitive. It was adopted to address the limitations of u-Seoul, which applied ICT to traditional city infrastructure. It involves communication and trust between the city, its agencies and citizens, as well as the sharing of knowledge, information and experiences. The focus of Smart Seoul is on efficiency, data-driven innovation and smart employment.
How	Smart Seoul Infrastructure is based on the ICT framework essential for providing smart services. It focuses on three components: ICT infrastructure, an integrated city management framework and smart users. By publishing the city's administrative information, creating open source data sharing and developing apps, Smart Seoul provides the most valued services and information demanded by its citizens. The city provides a free Wi-Fi system in public spaces, and PPPs provide high-speed internet access; Wi-Fi on subways, trains and buses; and refurbished smart devices to more vulnerable populations to improve access to Smart Seoul and give them a voice. Some examples of Smart Seoul are Smart Work Centres for public officials so they can work close to home; community mapping to allow people to participate in administering their communities and neighbourhoods through peer-to-peer communications among citizens; U-Net for direct communication with city services; and education courses for smart citizens to further enhance their knowledge.
Scale	The City of Seoul has taken Smart Seoul to scale and continues to expand its versatility and use by continuously adding new services and drawing on citizen innovation.

Theme: | **Environment**

Air pollution prevention; land protection and rehabilitation; water protection and rehabilitation; biodiversity protection and rehabilitation; urban resilience and adaptation to climate change

The systematic approach to urban development guides cities to further strengthen their disaster preparedness and resilience through protection and rehabilitation on water and land. Cities not only lead physical and digital infrastructure projects to make their cities resilient and disaster-proof, but also launch public educational campaigns to drive long-term behavioural change towards more environmentally conscious actions.

CASE STUDY 16 | **Hydrogen From Sewage – Fukuoka, Japan**

What	The City of Fukuoka has created hydrogen from city sewage to power fuel-cell vehicles.
Why	It is vital to work towards a low-carbon society while using cutting-edge technology. Electric cars are already gaining in popularity in the city; however, Fukuoka faces challenges, such as lengthy charging and comparatively short distances that the cars can run. Therefore, an alternative was pursued.
How	The biogas from processing the sewage created daily by Fukuoka's 1.58 million citizens generates hydrogen, which can be pumped into fuel-cell vehicles at the special fuelling station built by the city. Fukuoka is collaborating with multiple universities and companies that are making progress in the field of hydrogen research.
Scale	Since the project's launch four years ago, the hydrogen energy derived from household sewage not only fuels regular cars, but also powers motorcycles and logistic trucks in the city centre. Fukuoka wants to use this energy not only for mobility needs, but also to develop a variety of energy provisions throughout the city.

The city believes the project will help enable resilient, disaster-resistant urban development, as the energy can be used as a reserve in emergencies. |

CASE STUDY 17 | **Ahmedabad Heat Action Plan – India**

What	In 2015, Ahmedabad became the first Indian city to create a comprehensive early warning system and preparedness plan for extreme heat events (Ahmedabad Heat Action Plan [HAP], 2019 Update).
Why	Extreme heat events are becoming more common with climate change. The death toll in cities can be frightfully high due to the urban heat island effect and other factors. The poor are especially vulnerable.

How

According to the Ahmedabad Heat Action Plan guide, the HAP relies on four key strategies described as follows:

– **Building public awareness and community outreach** to communicate the risks of heat waves and implement practices to prevent heat-related deaths and illnesses, using traditional and social media

– **Initiating an early warning system and inter-agency coordination** to alert residents of predicted extreme temperatures forecasted by the Indian Meteorological Department; formal communication channels alert government agencies, health officials, hospitals, emergency responders, community groups and media outlets

– **Capacity building among healthcare professionals** to recognize and respond to heat-related illnesses

– **Reducing heat exposure and promoting adaptive measures** by launching new efforts, including mapping high-risk neighbourhoods, increasing access to potable water and cooling spaces on hot days, and other methods.

Collaboration was key. The Ahmedabad city government partnered with the Indian Institute of Public Health, Public Health Foundation of India, Natural Resources Defense Council, Icahn School of Medicine at Mount Sinai, New York (USA) and Rollins School of Public Health at Emory University, Atlanta (USA), to deliver the plan.

Scale

Before scaling the initiative, a formal study was undertaken to prove that Ahmedabad's HAP saves lives. To achieve scale, it required engagement with India's National Disaster Management Authority (NDMA) and the Indian Meteorological Department. Currently, more than 30 Indian cities have developed HAPs using NDMA guidance based on Ahmedabad's experience.

CASE STUDY 18	**Tenjin Big Bang Project – Fukuoka, Japan**
What	The Tenjin Big Bang Project features disaster-resistant urban development through redeveloping the city centre with relaxed regulations to attract private finances.
Why	Private buildings in Fukuoka's city centre are deteriorating. Suffering from countless earthquakes, the city wants to progress its disaster-resistant urban development by reconstructing underutilized structures into aseismic buildings. In addition, these earthquake-proof buildings are designed to be equipped with the latest information technology to provide a business-friendly environment for enterprises. Fukuoka's public spending, however, is predominantly taken up by welfare-related services, so the city did not have the financial capacity to support this kind of urban development.
How	Fukuoka came up with incentives to encourage private companies to rebuild these underutilized downtown areas. The city's international airport is close to its city centre, and under the national legislation, the heights of buildings in the area are restricted. Fukuoka's city council collaborated with the national government to make an exception for the city to relax the height regulations, thus allowing for taller buildings. Furthermore, the city offers deregulation opportunities for buildings that have a floor area ratio of the aseismic designs, for public green spaces or for free public spaces.
Scale	The initiative attracted many private developers who presented their disaster-resistant renovation proposals as well as well-designed buildings with public spaces. Without relying on public spending, the city has been able to rejuvenate and improve the city centre's public functions through deregulatory approaches; these create a win-win opportunity engaging the private sector, piloting an innovative partnership model towards sustainable urban development.

CASE STUDY 19 | **Water-Conscious Urban Development – Fukuoka, Japan**

What

This initiative uses ICT for water-conscious urban development.

Why

Fukuoka, the only major Japanese city without a large river, is prone to water shortages. In the past, the city suffered severely from large-scale droughts. Therefore, Fukuoka required a scheme that distributed its limited water supply carefully and efficiently to each citizen.

How

The city developed a system that can simultaneously monitor and control the water flow and pressure to be supplied to each area of the city via special sensors. This system can increase and decrease the water pressure in specific areas as required under precise operation. It monitors and controls the water leakage.

Additionally, using prediction models based on analytics from the sensor data in the system, the city can forecast how much water each area requires, achieving an effective water distribution channel throughout the city.

Public awareness projects and tangible technical optimization are both essential to achieve water-conscious urban development. The citizens of Fukuoka are educated on the importance of saving water at school and through various civic engagement opportunities. As a result, 90% of the city's citizens are dedicated to saving water. Moreover, the amount of water used by Fukuoka citizens is the smallest among all of Japan's major cities.

Scale

This system, under operation for many years, is now fully adopted across the city. Fukuoka's leakage rate fell to 2%, considered to be a top-level standard globally.

| CASE STUDY 20	EDGE Olympic – Amsterdam, the Netherlands
What	EDGE Olympic, the headquarters of EDGE Technologies in Amsterdam, is a WELL-certified flagship smart building that connects every physical component of the building and every user of the space through a single cloud platform. An open ecosystem, it fosters a healthy environment for the well-being of users and is energy neutral and sustainable through efficient management.
Why	An office building serves not only as a place for productivity but also as a place that encourages connection and interaction. A company's physical office space complements its growth and creativity.
How	According to the EDGE Olympic website: "The building is based on a digital infrastructure that connects everything and everyone within its walls to a single cloud platform. A smartphone app lets users personalise their workplace, with the possibility to customise the lighting and temperature, continuously measuring noise levels and air quality to inform choices. This same technology also lets users access the building, quickly locate their colleagues, and find available meeting rooms or workplaces. The sophisticated digital infrastructure is flexible, making it future-proof. Extra services can be easily added to meet the changing needs of tenants and users. This enables EDGE Olympic to continuously update its system to contribute to user comfort, productivity and creativity." In addition, "EDGE Olympic brings the latest research and technical innovations in health and wellbeing together and was designed to minimise its environmental impact. The building is the first in The Netherlands to receive the WELL Core & Shell Platinum Certification and is now also the first in the world to be awarded with a Platinum WELL Certification through the WELL V2 pilot for EDGE's Headquarters. In addition, EDGE Olympic has an Energy Label A and a BREEAM Excellent certification."
Scale	Similar smart, sustainable and people-focused workspace projects have been replicated by EDGE in Berlin (EDGE Grand Central), Rotterdam and Hamburg.

Theme: # Business and economy

**Urban business environment; private-sector investment; development
of a competitive economy; green growth**

Cities seek to create a healthy competitive environment for small and medium-sized enterprises, develop policy incentives to encourage business growth and attract private interest to solve urban challenges. An ecosystem of innovation further attracts private investments, encourages entrepreneurs to expand their businesses and provides valuable economic growth. Agile cities experiment with top-down mechanisms to curate the ecosystem and protect citizens' rights through screening and governing grassroots initiatives.
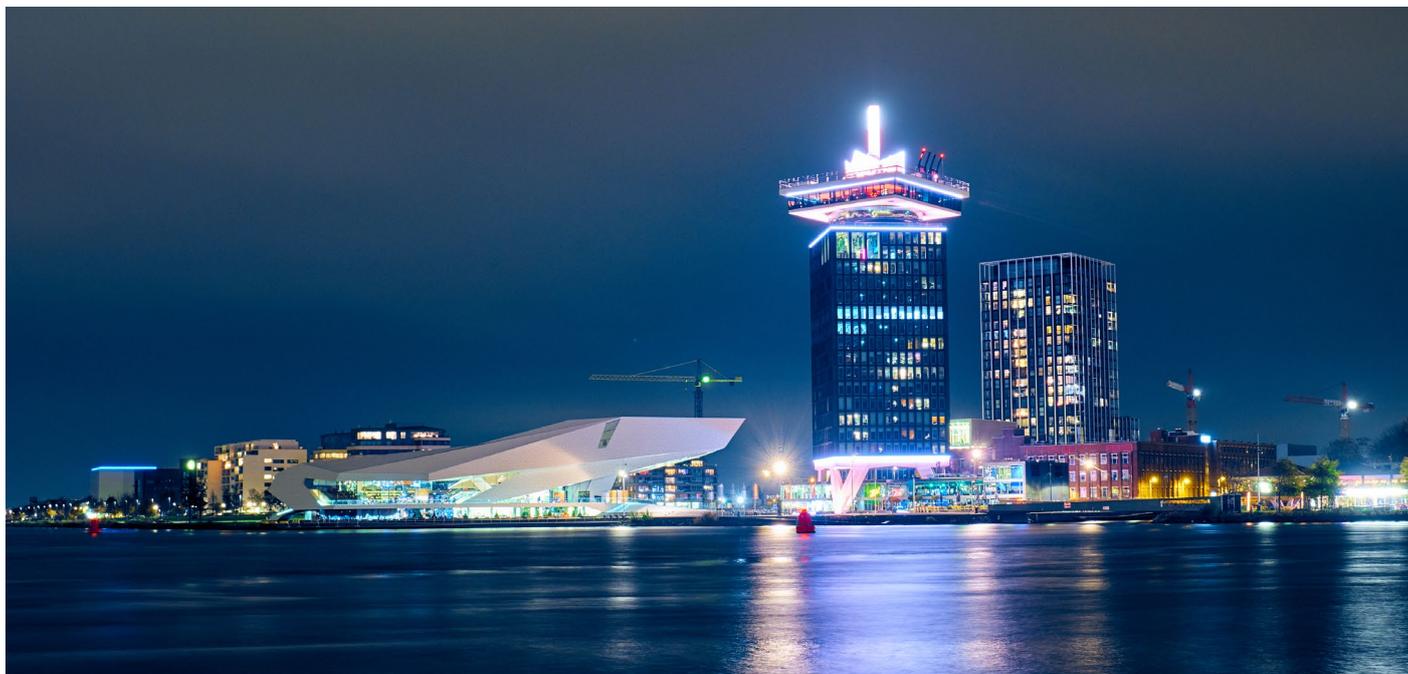
CASE STUDY 21 | **The Platform Economy – Amsterdam, the Netherlands**

What	To ensure the public can trust the platform economy in the City of Amsterdam, the city has been leading audits and oversight activities (algorithm audits, privacy audits) to restore trust among users.
Why	The rise of the platform economy has introduced a convenient way to match those in need of services to those who offer them. Public trust in platforms, however, has been damaged and in an effort to restore this trust, the city has been undertaking audits or oversight activities.
How	As a part of its digital agenda, Amsterdam has developed a standard for auditing algorithms together with universities and industry. In the near future, the city will ask companies that operate in Amsterdam to submit algorithms for auditing. Amsterdam is assessing 25 of its own algorithms to ensure the methodology is suitable to apply in permits, concessions or contracts with private-sector parties.
	Together with the United Nations, the European Union and the national government, the city will put the algorithms auditing standard in a declaration, Cities for Digital Rights, to scale up. Parameters are categorized as honesty, safety, inclusivity and privacy.
Scale	Amsterdam has hundreds of platforms. Under A Digital City for and by everyone agenda, the algorithms used by the city were audited by an independent party in 2019.

CASE STUDY 22	**Dubai Blockchain Strategy – UAE**
What	The Dubai Blockchain Strategy aims to make Dubai the first blockchain city by 2020. It entails more than 20 public- and private-sector use cases from eight sectors.
Why	Multisector, multiparty use cases are specifically selected to benefit most from blockchain technology due to their need for third-party elimination, transaction ledgers and smart controls creating transparency and efficiency.
How	City-level governance is achieved through a joint public- and private-sector council, with blockchain policies developed for compliance and guidance. Use cases are selected through multistakeholder engagement and ideation. An agile process is applied for prototyping and lean design thinking. In addition, a PPP model is leveraged for implementation. Blockchain was identified as a strategic sector for government efficiency, economic sector creation and international leadership. The Global Blockchain Challenge was undertaken, enabling new start-ups in the city to solve real urban challenges in Dubai.
Scale	To scale blockchain, over 20 use cases were identified through multistakeholder engagement and participation. Two pilots were initially identified and delivered as quick wins (digital payments reconciliation and Dubai land title deeds). Scalable and phased technology implementation provided as BaaS (Blockchain as a Service) to city entities created significant operational efficiencies. Implementation of parallel use cases was enabled on the blockchain platform.

CASE STUDY 23	Repair Cafés – Amsterdam, the Netherlands
What	Repair Cafés are free meeting places in Amsterdam where objects can be repaired. Tools and materials can be found there to mend clothing or fix furniture, electrical appliances, bicycles, appliances and toys, among other things.
Why	Densely populated urban areas consume many of world's raw materials, especially wealthy cities such as Amsterdam. Traditionally, heavy consumption also means a lot of waste. Repair Cafés reduce waste by extending the life of various goods.
How	The open and communal approach to Repair Cafés is its underlying force. Everyone around the world can visit https://repaircafe.org and download their starter kit.
Scale	Repair Cafés count 1,500 locations worldwide. At the start of 2019, about 20 Repair Cafés were active in Amsterdam.

CASE STUDY 24 | Circular Glasgow – United Kingdom

What	Circular Glasgow is an online platform designed to support the implementation of circular business models and strategies to tackle universal and local challenges. Glasgow was the first city to host an online challenge, reaching over 600,000 people globally with 59 ideas submitted from 13 countries. The partnership with the design studio Graven, the first of its kind and a result of the city's global design reputation, led to the launch of a bespoke consultation programme and resulted in 10 design-led circular innovations.
Why	Cities need new ways to address waste. The International Resource Panel (IRP) estimates that with business as usual, material consumption by the world's cities will grow from 40 billion tonnes in 2010, to about 90 billion tonnes by 2050. According to the World Bank as reported in the 2018 World Economic Forum White Paper "Circular Economy in Cities", cities generate "1.3 billion tonnes of solid waste per year, which translated into a footprint of 1.2 kg per person per day in 2012. This is expected to rise to 2.2 billion tonnes by 2025. Traditional waste management and disposal practices result in landfill sites or pollution of the environment if not well regulated. There is a need to embrace a more viable method of production and consumption in the overall value chain to ease the burden of waste on urban areas. The circular economy approach aims to reshape resource use by decoupling growth from material extraction. The intention is to create a more sustainable future that allows the natural environment to restore resources and protects it from the negative effects of industrialized waste."
How	According to the Circular Glasgow website, the project team "work closely in partnership with Zero Waste Scotland, Glasgow City Council and Circle Economy to deliver a programme of business engagement to raise awareness of the benefits and opportunities of the circular economy." The initiative has 19 "ambassadors from businesses across Glasgow who are helping to share their experience and knowledge of the circular economy."
Scale	The Young Global Leaders (YGL) Circular Economy Taskforce in its *Circulars 2019 Yearbook* states that, "Over 550 businesses have been engaged, with Circular Glasgow helping to increase revenue streams, realize financial savings and enhance competitive advantage using a range of practical tools. Next steps will be to build on wider business engagement, alongside academia and the public sector."

CASE STUDY 25	The Mayor's Civic Innovation Challenge – London, United Kingdom
What	The initiative is a mission-led approach to solving citywide issues with technology, with a financial incentive for small and medium-sized tech enterprises to participate.
Why	The Civic Innovation Challenge (CIC) creates a platform through which citywide problems can be solved, providing incentive for London's innovation base to work on areas of strategic importance to the city.
How	The mayor partnered with seven large organizations from the public and private sectors to design challenges which tech companies were then invited to solve. After an application phase, companies deploying AI, virtual reality and wider digital technology were given £15,000 to deploy a live project. For the mayor, the CIC ensures London can reap the benefits of its tech sector; for the companies, it provides access to market, validation and traction for their cutting-edge services.
Scale	The CIC is scalable by design, focusing on the key areas of climate change, inequality and ageing population. The outcomes are deployable across London and most major cities. In the current Civic Innovation Challenge, finalists are supported with up to £40,000 to the pre-commercialized stage of product delivery.

(6) Conclusion

Cities are undergoing rapid digital transformation and are experimenting with inclusive and innovative models to integrate Fourth Industrial Revolution technologies into their programmes, infrastructure, services and governance. A city becomes smarter with the advance of digital infrastructure that enhances the connectivity between physical space and city management systems, as well as the communication channel between citizen and local government. Through big data analytics and IoT, a new urban social contract is gradually formed between local government, businessesand individual citizens. The actuation feedback system further enables each actor to become part of the solutions to urban challenges, as well as end users themselves.

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