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Building the smart city

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Smart city 2.0:
The second wave in smart city transformation

The term "smart city" doesn't describe a sci-fi utopia. A smart city is simply one that uses technology to improve outcomes across every aspect of city operations and enhance the services it offers to its residents. It collects and uses data to drive its decision-making, and creates networks of partners among governments, businesses, nonprofits, community groups, universities, and hospitals to expand and improve its ability to serve its residents.

Until recently, discussions of smart cities focused on infrastructure: big data and information technology used to better manage urban assets such as public transit, wastewater systems and roads. In many ways, this "connected infrastructure" vision represents Smart City 1.0 — physical assets networked via sensor technology that generate streams of valuable data from "smart" parking meters, streetlights, and so forth. For many cities, this is still a powerful vision.

Some more advanced smart cities have begun to move beyond infrastructure. A truly smart city leverages new-found data to tap the wisdom of its residents and visitors. The digital infrastructure of a smart city allows access to data that can unleash tremendous value, driving smarter decision-making by planners, community groups, and individual residents.

Today, cities operate at the intersection of the 3Ds: Data, Digital, and (user) Design. These are the building blocks of a second wave of transformation, Smart City 2.0. It is fundamentally about applying a different "lens" to use a combination of digital technology, data, and design thinking to drive improvement initiatives and focus on the constituents. City officials, businesses, nonprofits, schools, and individuals alike will be able to use a treasure trove of data to make more effective decisions in arenas from energy use to mobility.

Cities are the engine rooms of growth and prosperity

Cities have always been centers of innovation and prosperity; the concentration of commerce and humanity drives economic growth and innovation. Today, however, many urban centers around the world are undergoing truly explosive growth (Figure 1). More than half of the world's population currently lives in towns and cities, and by 2050 this number could swell to about 66 percent, or about 2.5 billion people.[1] Population pressure is forcing many cities to reconsider the way they deliver services.

By 2025, the world's top 600 cities are expected to account for 60 percent of global GDP.[2] Today, London accounts for almost a fifth of the United Kingdom's gross product.[3] In the U.S., the Northeast corridor (Boston to Washington, D.C.) and the Los Angeles metropolitan area together account for nearly a third of national GDP.[4] A World Bank analysis of 750 cities around the globe found that, from 2005 through 2012, economic growth in 72 percent of cities outpaced their respective national economies.[5]

Cities, then, are critical engines of growth. We need to keep them growing economically.

Figure 1. Urban and rural populations of the world, 1950–2050
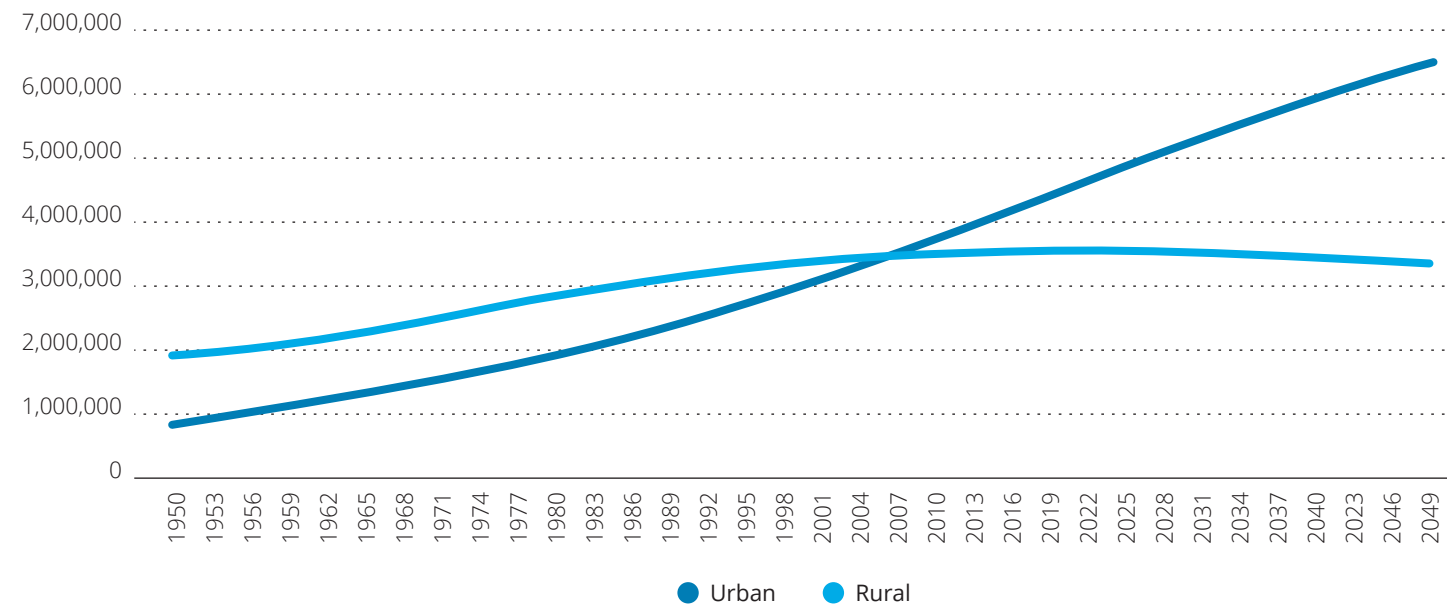
Source: United Nations Department of Economic and Social Affairs, Population Division, World Urbanization Prospects (2014 revision)

Cities can become smarter

The rapid pace of urbanization, wealth concentration, and innovation places enormous pressure on cities to rethink the way they provide even the most basic services. These pressures require urban centers to connect with residents, businesses, and nonprofits in new ways that go beyond simply expanding physical infrastructure.

Consider Amman, Jordan's capital city. Between 2004 and 2015, Amman's population more than doubled, from about 2 million to more than 4 million, straining its infrastructure and public services. Driven largely by the Syrian refugee crisis, Amman has absorbed about a million new residents in just three years.[6]

With such rapid growth, the city faced enormous challenges in managing its solid waste. Leaders recognized that poor solid waste management—street sweeping, household pickups and disposal in landfills—can undermine confidence in government and disrupt economic growth.

To address these challenges, the city took a data-driven approach to streamline the waste management process.[7] City officials now can monitor factors such as waste tonnage per district and complaints resolved, and track vehicles through a new fleet management system. Garbage trucks that once returned nearly empty, for instance, are redirected to routes where full trucks have skipped collections.

A data-driven management model combined with enhanced technological capabilities has generated positive results for Amman. This kind of "chipping away" at the problem approach is central to a smart city movement and many such innovations are happening in different areas of the world.

Buenos Aires uses technology for more responsive service delivery[8]

With a population of more than 3 million spread over 78 square miles, Buenos Aires owns more than a million pieces of public infrastructure, including 370,000 trees, 120,000 public lights, 56,000 sidewalks and 28,000 storm water drains. Maintaining such a vast public infrastructure is a constant challenge. The city has long allowed citizens to log complaints or service requests through a call center for everything from fixing potholes to removing graffiti. Unfortunately, the feedback mechanism was largely ineffective. In 2011, the city's turnaround time for complaint resolution averaged 600 days—almost two years to fix a single problem.

In 2010, the city hall resolved to do better. Part of the solution was a new IT system that streamlined information flow and improved departmental coordination. The city launched a platform through which citizens could register complaints through social media and other channels. The granular data Buenos Aires collects through this system allows it to create hyperlocal solutions for certain areas.

The responsive system had a tremendous impact on the city's quality of life. The average time to resolve a complaint has fallen 93 percent, with no effect on the city budget. The city fixes more problems in less time, and has seen an uptick in almost all satisfaction measures.

A Smart City *works for* its residents, visitors and businesses

The heart of any smart city is its people. City residents want to live in safe, healthy places that offer economic opportunities. Most cities across the world are striving to meet three objectives:

- a better quality of life for residents and visitors.
- economic competitiveness to attract industry and talent.
- an environmentally conscious focus on sustainability.

These three goals—quality of life, economic competitiveness, and sustainability—should be the cornerstones of a smart city initiative.

The key point is that city leaders and citizens are trying very hard to improve the quality of life in their cities, and they are willing to look anywhere for good ideas. If cities experiment enough, in partnership with the private sector, you're going to see innovation flower and spread around the world.[10]

—Daniel Doctoroff, CEO, Sidewalk Labs

Quality of life

Prosperity no longer requires noisy, hectic, stressful living. By using technology and smart policies, cities can deliver services faster and more reliably, with an increasing focus on residents' actual needs. While quality of life is inevitably a subjective measure, and thus hard to measure, it can be sensed through the way in which cities care for their citizens' health, safety, and security.

In 2009, for instance, the city of Boston created Citizens Connect, a smartphone app allowing citizens to report nuisances such as potholes, dead raccoons or code violations, even if they don't know the proper government department. In 2012, the city followed up with City Worker, a program that alerts public works employees to trouble spots reported by Bostonians that allows city workers to resolve problems faster.[9]

Identifying Sydney's innovation hotspots[12]

Data from the Australian Bureau of Statistics suggested that about 138,000 businesses in Sydney can be considered "non-innovators," meaning they haven't reported the introduction of a significant change in business practices in the past three years.[13] That's one in three Sydney businesses. According to the Australian Innovation System report, the average gross operating profit for new-to-business innovators was $297,000, more than double the average profit of non-innovators. While correlation doesn't imply causation, those high profits were worth trying to recreate across greater Sydney.

To understand what drives innovative businesses and ecosystems, an intensive data analysis was performed resulting in 18 economic indicators in a "Create Heat Map," which visualizes a neighborhood-by-neighborhood index of innovation in greater Sydney. The data are intended to help policymakers identify potential pockets of innovation, investigate the factors at play, and encourage their growth.

The Create Heat Map enables city leaders to check the city's economic pulse. Detailed geographic information about innovation hotspots can help city managers attract desirable businesses, direct investment appropriately, and educate non-innovators on best practices. Infrastructure, regulatory schemes, and resident support should all be designed with innovation in mind.

Economic competitiveness

Quality of life alone does not indicate a city's well-being. A successful city needs a dynamic and thriving economy that offers its residents a chance for prosperity.

Cities should employ a two-pronged approach to drive economic competitiveness—strengthening the talent pool and improving the business environment. In survey after survey, talent tops the list of the most important factors determining competitiveness. As the World Economic Forum notes: "A strong innovation capacity will be very difficult to achieve without a healthy, well-educated, and trained workforce."[11]

Sustainable growth

Sustainability isn't a sprint, it's a marathon. Advances represent little actual progress if they degrade the air, water, and soil. Cities know this, and most thriving cities seek sustainable growth.

The city of Boulder, Colorado, for example, is partnering with local utility Xcel Energy to test various smart grid technologies.[14] Like many governments around the world, Boulder incentivizes solar-powered homes and energy-efficient renovations. In the long term, a smart grid infrastructure can help individual homeowners increase energy production and contribute to the energy market.

New York's sustainable growth plan[14]

PlaNYC, the city of New York's 2007 long-term strategic plan, strove to answer two questions: How can we accommodate 1 million more people in New York over the next 25 to 30 years?[13] And how can we dramatically reduce the city's carbon emissions at the same time? The plan incorporated 127 separate initiatives that considered transportation, land use, energy, water quality, air quality, water reliability, brownfields, parks, and housing—essentially every aspect of the physical environment.[15]

Smart city initiatives in action

Cities are complex economic and cultural ecosystems. For civic leaders worried about the details of implementation, the technology can seed change in six urban domains: economy, mobility, security, education, living, and environment.

Economy

A thriving economy boosts personal income and provides much-needed tax revenue. Cities looking to revitalize their economies should think creatively about policies that accelerate talent development, economic growth, and productive employment. The smart economy of the future is expected to be both seamless and dynamic. The ubiquity of digital technology and other emerging technologies, moreover, will require government regulatory machinery to become more nimble and responsive.

Cities should create conducive environments for businesses, both big and small, to thrive. Boston, for instance, made streamlining its permitting process a top priority. The city prototyped multiple applications through a civic "hackathon" and developed the best entries. The effort yielded postive results: a backlog of 3,500 building complaints was reduced to 212, the city inspection services issued 12,500 more permits in 2013 than 2014, and average review time for long-term permits was cut by 20 percent.[16]

Some major trends shaping the smart economy of the future include:

- An open talent economy, as remote working capabilities and independent contractors create a shift to a borderless workplace.[17]
- Training tuned to match the skills required, resulting in shorter training periods, a reduced skills gap, and faster job creation.[18]

- The rise of innovation labs that devise products and solutions to societal problems while providing a "safe" space for innovation and collaboration.[19]
- Business ecosystems evolving around key areas such as health care, transportation, and education, forming dynamic and collaborative networks to solve real-world issues.[20]

Mobility

Mobility becomes as much about bits and bytes as roads and rails. Today, traffic congestion is being addressed with sensor-powered dynamic pricing and mobile-enabled, collaborative transport models such as ridesharing and social transport apps. Already, we're seeing digital platforms that integrate end-to-end trip preparation, offering planning, booking, electronic ticketing and payment services across all modes of transportation, public or private. Mobility thus is becoming a service.

Helsinki, Finland, represents the next revolution in mobility as a service. The city wants to make it unnecessary for any city resident to own a private car by 2025. Since 2016, Helsinki residents have been able to use an app called Whim to plan and pay for all modes of public and private transportation within the city, whether train, taxi, bus, carshare, or bikeshare. Anyone with the app can enter a destination, select a form of transit, and go. Users can either prepay for a monthly pass or pay via their phone for each trip. It's a marked departure from how most cities deliver mobility now.[21]
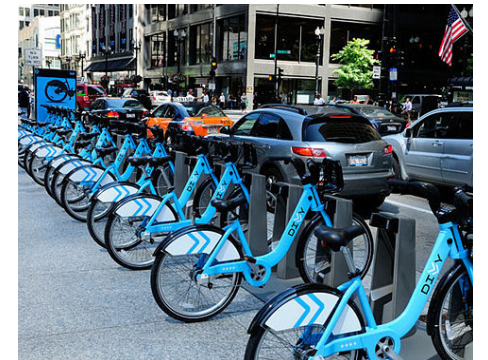
But mobility-as-a-service isn't the only trend driving this domain. Other trends that will affect the way cities adapt for mobility include:

- Dynamic pricing, which allows prices to fluctuate based on time of day, road congestion, speed, occupancy and even fuel efficiency and carbon emissions.[22]
- Smart parking, which provides drivers with real-time information on the nearest free and paid parking spaces.[23]
- Truly autonomous vehicles that maintain smooth traffic, safely reducing distances between cars and thus increasing road capacity.[24]

Smart city initiatives in action

Security

As crime becomes smarter and high-tech, public safety and security agencies must adapt to it. Law enforcement officers already use drones, wearable computing, facial recognition, and predictive video to fight crime. Data will play an increasingly important role in crime prevention as agencies try to preempt crime. Agencies now can analyze all streams of data, including social and crowdsourced data, to identify hot spots for street crime and deploy police more efficiently.

The answer to policing of the future is not the militarization of law enforcement units but rather smarter policing and surveillance through technology and data. Consider Alburqueque, New Mexico, where the police department has installed mobile surveillance cameras in parks around the city. These aren't your average surveillance cameras; police officers can access the cameras from mobile devices to view live images and can remotely control them. They can monitor the cameras during critical situations such as negotiations with hostage-takers or SWAT raids. In less urgent situations, the cameras can send images and videos via a 4G wireless signal back to the city's Real Time Crime Center for further analysis, with footage from more than 100 traffic cameras and 300 private cameras positioned throughout the city.[25]

Cities also must become better equipped to mitigate and respond to cybersecurity issues. Secure data platforms, clear governance and smart access protocols can help safeguard data against inevitable hacking attempts.

The major trends affecting the security domain in a city include:

- Real-time crowdsourcing of crime data (incidence, degree, and nature) and the creation of large databases that can be used to identify areas meriting greater security.[26]

- Drones or unmanned aerial vehicles (UAV) technology that can act as scouts for first responders, minimizing risks for police officers or fire rescue workers in dangerous situations.[27]

- Augmented-reality security screenings at airports and infrastructure hubs, which can reduce human error with automated facial and behavioral recognition.[28]

Living

"Smart living" encompasses areas like health care, human services, and even smart infrastructure such as connected homes and smart buildings. Cities can promote tools that help residents monitor their health, wire their homes to improve energy use, or deliver more tailored human services. Coupled with new data approaches such as predictive analytics and insights from the field of behavioral economics, smart living helps citizens to make better choices.

Significant improvement in health outcomes could come from big data analytics. City administrators use geospatial analysis to visualize complex data on maps, enabling them to target neighborhoods for specific interventions. Such analyses can visualize the geographic extent and impact of problems such as child abuse and neglect, drug abuse, unemployment, and health issues. The data often invite meaningful questions about factors that drive these specific challenges, and let administrators focus resources on the neighborhoods—or even particular housing developments—in need.[29]

Hospitals of the future will educate patients and enlist them to actively participate in their own care before, during, and after a hospital stay. For instance, the Ohio State University piloted the OSUMyChart app in its James Cancer Hospital and Ross Heart Hospital. Patients can use bedside tablets to set medication alarms, directly schedule physician and relative visits, view test results, research their diagnoses and make requests for water, snacks and help going to the toilet without using a nurse call button.[30]

Major trends that could enhance smart living include:

- Smart homes connect with electronic devices that allow real-time monitoring of a home's energy use and security.[31]

- Predictive analytics that tell city administrators which social interventions have a higher rate of success in each client's individual circumstances.[32]

- Wearable devices that track personal health data and make their users more receptive to behavioral nudges. Policymakers can use them to reward healthly lifestyles.[33]

Environment

As natural resources become scarcer, especially in a population-dense urban environment, reducing resource consumption can multiply financial and public health gains. Smart cities use sensor technology, behavioral economics, and gamification to improve physical infrastructure and encourage positive decisions.

Even streets can save energy. Copenhagen, for instance, has installed a growing network of smart streetlamps and sensors as part of its goal of becoming the world's first carbon-neutral capital city by 2025. LED streetlamps brighten when vehicles, bicylists and pedestrians approach but dim after they pass. The sensor-enabled light fixtures also can capture data and help coordinate services by, for example, alerting the sanitation department to empty full trash cans.[34]

Sensors are not unique to the Danes. Embedded sensors can perform tasks from pollution monitoring to land management. Environmental agencies rely on sensors for continuous environmental monitoring and automatic intervention, thus reducing the need for on-site visits.

Other trends that can drive sustainability and smart energy usage in cities include:

- Smart meters that help utilities to balance energy consumption and implement dynamic pricing.

- Distributed energy sources that transform consumers into "prosumers," allowing homes and offices to both consume and generate electricity.[35]

- Embedded sensors that monitor everything from pollution to land management, supplementing or replacing on-site inspections.[36]

Education

Education enabled by virtual learning, digitization, and augmented reality can transform the way we learn. Unbundled, personalized, and blended education will become more prevalent. Guided by rich data and analytics, next-generation teachers can adapt their techniques to maximize student success.

The technological focus will shift from digital content in the classroom to real-world experiential learning. Rhode Island's Metropolitan Regional Career and Technical Center's (MET's) Big Picture Learning program envisions redesigning K-12 and adult education. MET students learn outside the classroom with a mentor who is expert in the students' field of interest. Through this Learning Through Interest (LTI) program, advisors meet with students and mentors at an LTI site to help students develop real-world projects and build long-term personal relationships with their mentors, paving the way for lifelong learning.[37]

Other major trends affecting the way we learn and use knowledge include:

- Blended learning models that mix elements of in-person instruction with self-paced online learning. Such models allow students to watch video lectures online at home and then spend class time solving problems, thus getting the most from the one-on-one time students spend with teachers.[38]

- School-business collaborations that help teach job-specific skills.[39]

- Adaptive counseling that uses computers to analyze data for insights into the needs and strengths of individual students.[40]

Smart city, smarter constituents

Physical infrastructure is of course an important element of a smart city, offering enhanced mobility, smarter city services and more efficient energy use. But the smart city promises much more than Wi-Fi hotspots and self-monitoring trash cans. To be worthy of the name, a truly smart city should use technology to promote better decision-making for all its residents.

Installing sensors that collect data for optimizing the performance of physical devices is part of what it takes to achieve the smart city. Going the last mile involves using technology to tap into the city's greatest asset: its residents. Smarter decisions by residents and businesses can come about in many ways. Sometimes, simply providing real-time data will promote better decision-making. More generally, however, cities should be looking toward a variety of modern techniques to help people make more informed choices. Data science, behavioral economics, and digital technology can empower more effective decision-making.

This shift the focus away from top-down efforts by putting information in the hands of residents when they make personal decisions. In San Francisco, for example, Harvard University economist Mike Luca worked with Yelp to put information about city restaurant inspections into the hands of diners. This sort of public information can "nudge" users into making better, or at least more fully informed, decisions.[41]

To realize the full power of a smart city, it's critical to engage the people who live there. After all, the ultimate goal is to make cities a better place to live and work, not just more efficient providers of infrastructure and services. Human-centered design thinking promotes collective intelligence, and is central to the smart city movement.

Five factors leaders need to get right

A strong smart city framework can demystify the complexities of bringing smart technology to a city. City leaders can use this framework to build their own strategies. Such strategies, however, should consider five key factors:

1. Vision

Before embarking on any significant smart city initiative, determine what being a "Smart City" actually means to your city, and how to measure progress toward your goals. A basic statement such as "We want to be more connected" isn't enough. Successful Smart City visions should be ambitious but specific, with clear criteria and timeframes for success.

2. Ecosystem

Public-sector stakeholders play critical roles in making cities smarter, but embracing smart city principles while still operating within traditional government silos can be a recipe for wasted effort. The smart city of the future must convene problem solvers and think beyond traditional boundaries. This requires it to assemble an ecosystem of partners across government, established businesses, startups, the academic sector, and the nonprofit world.

3. Governance

Because they often seek to unite this diverse ecosystem of stakeholders, smart cities require clearly defined governance. City leaders, regional governments, transportation districts, corporate and nonprofit partners and, depending on the funding model, state and federal agencies may all participate in establishing and executing a smart city vision. Stakeholders should be able to articulate their responsibilities, ensure that appropriate information flows to the right decision-makers; and give the people with the authority to make decisions a stake in the outcomes. Establish accountability up front and create mechanisms to drive timely decisions.

4. Technology underpinnings

The precise technology required for each Smart City will differ according to each city's unique needs. All smart cities, however, should integrate the technological foundation of their efforts, including system architecture, data governance, interoperability, and cybersecurity.

5. Funding

Novel approaches to municipal governance deserve novel approaches to financing. Traditional funding sources such as tax revenue and municipal bonds can be supplemented by public and private funding from sources such as joint enterprises and contractual partnerships. Crowdfunding or "green" funding may be worth exploring as well.

Lessons from the trenches: Getting started with the journey

As the saying goes "it takes a village to raise a child." In a similar way, it requires engagement with many stakeholders to drive successful smart city programs; along with a strategic vision aligned with actual needs and clear communication with city residents. Here are a few ways to kick-start your journey.

1.
Start with a compelling business case. Present an idea city residents can easily understand and articulate.

2.
Document and clearly communicate the smart city vision to all ecosystem partners.

3.
Run the effort as a portfolio. Rather than a single, huge project, create a portfolio of projects, each with its own business case.

4.
Ensure the project management office has the authority to make decisions, with adequate accountability.

5.
Demonstrating success early is important, so employ a phased approach with a series of "small wins." Organize resources to make this happen.

6.
Communicate throughout the journey. Don't underestimate change management and communications—changing a culture and mindset takes time.

7.
Finally, focus on results. Pick three things to announce as successes one year from now to demonstrate progress.

Time to start

From the first aqueducts to subway systems and elevators, technology has always reshaped cities. In our era of explosive growth, digital and other emerging technologies will shape the way cities change. Allowing the rhythms and structures of civic life to strain against aging systems—in other words, doing nothing—would fail the hundreds of millions of people moving to cities seeking a better life. The smart cities movement has cities worldwide experimenting with emerging technologies and cutting-edge design approaches to improve the lives of their residents. The time to start this journey is now.

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