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Special Report

Smart Cities: A Toolkit for Leaders

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A Smart City is More Than Just About Technology

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When cities first embarked on the smart city journey, they focused on bringing the right technology on board. In this first phase, municipalities worked with technology partners to do such things as deploy sensors to manage utilities and used the data generated for descriptive rather than predictive analytics. Smart Cities 2.0 saw municipalities take a bigger lead role as they leveraged the Internet of Things (IoT) and used technology proactively and on a much wider scale to produce a better quality of life. In Smart Cities 3.0, the city positions itself as a platform that actively interacts, collaborates and co-creates with its citizens as valuable stakeholders.

> **"The four big pillars for smart cities are urban mobility, energy, telecommunications and public safety."**
>
> —JESSE BERST, chairman, Smart Cities Council

GETTING BACK TO BASICS

The mayor's first big test is to decide where to begin the smart-city journey. Start with the basics. "The four big pillars for smart cities are urban mobility, energy, telecommunications and public safety," said Jesse Berst, chairman of the Smart Cities Council. It's important to get the basics right before attempting higher profile projects. "Cities should be concentrating on what they need to do and what they can do best, which is very often not very glamorous," added Gilles Duranton, Wharton real estate professor. "These may have to do with the management of urban space, roadways, and how to deal with local public

goods — that's picking up garbage, making sure people get water, do not get lead poisoning, and so forth."

It's also important to think holistically, even with individual projects. For example, aim to maintain a high degree of connectivity with residents by offering a single-point access to services with a consistent user experience on one platform. The best way to achieve that is with "an integrated, cross-cutting approach," Berst said, where one app could connect citizens with different departments. It might help to think about the city as a business with the mayor as the CEO, said Robert Inman, Wharton professor of business economics and public policy. "The city is essentially the caretaker of land. … My job as the mayor is to manage that location."

As you craft a smart-city vision for guidance, focus on three aspects, said Seeta Hariharan, general manager and group head, Digital Software & Solutions Group, Tata Consultancy Services (TCS). One is how to drive innovation at the local level that would counter the challenges brought by rapid urbanization. Partner with local companies, which understand their markets better as well as the residents' needs and challenges. Second, redefine public-private partnerships in a way that includes the voice of labor unions. "Including the labor unions in these partnerships can close the digital gap and create more equal opportunities for everyone," she said. Third, "mayors have a responsibility of looking ahead and coming up with smarter regulations that keep pace with technology," Hariharan said.

For example, when cars were first allowed on the roads, it was illegal for them to drive faster than a horse and carriage under the Highways Act of 1861. Back then, people were worried about safety, and the maximum speed limit set for cars was four miles an hour. Cars, which were called "horseless carriages" back then, had to each have a three-man crew including a red-flag bearer, who would walk in front of the car and direct traffic as the car approached intersections.

That same sentiment could be at work today. "When we have a new technology in place, we tend to take the rules of the past and apply it to the new technology," Hariharan said. In much the same way, the laws governing driverless cars vary across states. In New York, for example, one cannot have a driverless car on the road unless it is escorted by a police car. "I was reminded of the 1861 Act and the red-flag bearer," she said. In some other states, even if one is operating a driverless car, the driver must have both hands on the steering wheel.

FINDING THE RIGHT FRAMEWORK

Before launching a smart cities project, it is important to set up the right framework for success. First, a city's leaders and financial backers must truly care about this endeavor, said Britt Harter, a director in the Sustainable Business Solutions practice at PricewaterhouseCoopers and leader of its Cities of the Future initiative. "Without that … push from the real leaders and the decision-makers, things will stall," he said. Second, cross-departmental facilitation is a must to get things done. But take note that it won't happen automatically. "You need a push from the leader," said Harter. "You need a reason for them to come together and make change, otherwise they will just wait out the meetings and then return to the status quo." Third, he said, city departments "need to know what to do; they need a plan."

Take the experience of Atlanta. Early on, the city prioritized the use of the latest technological innovations such as the IoT and big data analytics to improve the quality of life for its residents, according to the city's former CIO, Samir Saini. Those tools, especially the data component, drive decision-making and improve outcomes by enabling the switch from a reactive model to a proactive and predictive one. The other piece he saw as a "game changer" was the city's decision to set up an enterprise data platform with data links and analytics tools. It would aggregate data from multiple sources, contextualize the information and make it available to others who could use it to improve the quality of life in the city.

Illinois led the data and analytics effort itself. Hardik Bhatt, who until recently was the CIO of the state, dispatched at least five IT teams to develop mobile solutions for city services. The state was delivering one mobile app every month and cross-training employees on mobile technology. A central data analytics team is working with three state government departments to build analytics components. In 2017, cyber security training for government employees took off in full force, following a state legislature mandate.

However, 90% of the employees had already voluntarily joined the program. "You don't get all those gains if you don't have an employee base that is bought into the vision," said Bhatt, also formerly the CIO of Chicago.

To be sure, cities know that their grand visions will get moving only when there is economic growth and its accompanying larger tax base. That means cities have to attract both employers and skilled workers. But which do they entice first — the employers and then the talent will follow, or the other way around? "Talent first, employers later" seems to be the answer. Begin by making the city a desirable place to live and work for employees, which means investing in the amenities they seek, said Prasanna Tambe, Wharton professor of operations, information and decisions. For instance, a city might want to invest in mass transit systems to make mobility easier for residents and expand shopping, dining and entertainment options. Once a critical mass of talent becomes available, employers will follow.

Finally, it is easy to get excited about smart cities and overestimate what they could deliver and underplay any potential challenges. Be realistic. City leaders "work under the pretense of execution. That is, 'We need to drive this big plan and this big plan will be key in local economic development policies' to become the next Silicon Valley," Duranton said. "The reality is very sad – most of these never take off." Respect technology as an enabler, but don't allow it to dominate the decision-making process. "Historically, smart cities have had their agenda driven top-down by private sector vendors," said Adam Beck, executive director of the Smart Cities Council, Australia and New Zealand. "They have been trying to sell technology and don't necessarily understand how cities work." In the past, this way of selling made it challenging for cities to understand and buy into smart-city agendas. But that has since changed and cities now understand that technology is the enabler.

A CHECKLIST FOR SMART CITY LEADERS

- Focus on the basics first: urban mobility, energy, telecommunications and public safety.

- Craft a vision that incorporates these three aspects: driving innovation at the local level, including labor unions and other stakeholders, and making sure regulations keep pace with changing technologies.

- Set up a framework for success: Leaders and financial backers must truly care about the initiative, facilitate inter-departmental cooperation and give city departments a plan to follow.

- Be realistic about what a smart city can achieve.

Smart Cities: Identifying Needs, Finding Solutions

> "Analytics tell an officer which crime is most likely to happen in his or her neighborhood today, and can be watching out for that."
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After crafting a smart city vision, cities must prioritize their needs before they can find solutions, shortlist vendors, deploy equipment and implement projects to deliver the desired outcomes. Public safety is typically the topmost need for many cities, followed by other priorities such as connectivity, sustainability, resilience, equitability and inclusivity as well as job creation and economic growth. Below are brief snapshots of how cities can identify their needs in various domains and draw up a plan of action to meet them.

AREAS OF EARLY FOCUS

Public safety. Planning for and maintaining safety in urban settings call for a coordinated approach among departments and agencies. Technology can help — many U.S. cities are using data to do predictive analytics using data culled from multiple sources, such as video feeds from the traffic department's cameras and sensors on everything from water tanks to street lights and trash bins. Jesse Berst, chairman of the Smart Cities Council, said Charlotte, Va. is able to distill its analytics down to the individual level and "tell an officer which crime is most likely to happen in his or her neighborhood today, and can be watching out for that."

Analytics and cloud storage infrastructure also are helping police departments across the U.S. deploy body cameras, or bodycams, worn by officers on duty. The bodycams generate huge volumes of data, usually in terabytes, that conventional data storage facilities cannot handle. Oakland, Calif., which has deployed the largest number of bodycams of any U.S. city, is partnering with the product's

maker, Vievu, and Microsoft's Azure cloud platform to manage all the data they generate.

New York City and Aurora, Ill. are among other early adopters of bodycams. These cameras record incidents that help both prevent incidents of police abuse and to avoid false charges against officers. Meanwhile, Oakland reported a 75% drop in "use of force" complaints — to 572 in 2014 from 2,220 in 2009 — after it deployed bodycams. The city used 620 bodycams in 2009, and is now buying another 800 at a cost of nearly $1.3 million to cover its needs for the next five years.

Urban mobility. This is a priority that lends itself neatly to technological solutions. Mobile applications, or apps, not only provide access to mass transit schedules and purchase of tickets, they also can map optimal routes for drivers to avoid traffic congestion or accidents, supply weather information as well as pinpoint highway rest stops and calculate tolls. A bonus would be a reduction in the city's carbon footprint as a result of an improvement in urban mobility.

Sustainability. A few years ago, Orlando, Fla., which is home to Disney World and Universal Studios, decided to focus on energy efficiency as part of its sustainability objectives. That was a priority because it found that most of the greenhouse gas emissions came from the buildings in the city. It first targeted the worst offenders: buildings that were 50,000 square feet or larger, which turned out to be 5% of the total number of buildings. The city launched a program that would track energy performance in those buildings, and assign Energy Star ratings based on their energy efficiency. The program was designed to measure energy usage and reduce water usage. Over time, it could indirectly encourage property owners to make energy efficiency investments, although they are not required to do so.

Serving the needs of the most vulnerable. Cities increasingly want to become more compassionate towards the needs of the most vulnerable, such as the elderly, poor, disabled or underserved ethnic communities. In public transportation, that often involves last-mile and first-mile access, which essentially is to provide transport from residents' homes to mass transit stations and get to elder care centers, a job or other locations. "The typical job is accessible to only about 27% of its metropolitan workforce by transit in 90 minutes or less," according to the U.S. Department of Transportation (DoT). Compassionate cities would also try to have affordable mass transit for all neighborhoods and not just some parts.

"Most of the of the solutions we're talking about, especially in areas like transportation, are aimed at solving some of the underlying issues that we see in cities around

disadvantaged communities," said Dominie Garcia, smart cities program lead at Battelle, an advisory services firm. That could mean providing opportunities or access to transportation to communities that have traditionally been geographically isolated and are economically disadvantaged. Another example: efforts to bridge the so-called 'digital divide,' which may take the form of free public Wi-Fi. "Start with a needs-based assessment — what do we really want? What are the challenges and the problems we want to solve?" Garcia said. Such introspection, she added, is "an embedded piece of a smart city."

For Columbus, Ohio, it drafted a central data system to develop applications for the delivery of services. These included scheduling and automatically rescheduling of appointments with transit tracking, apps for multimodal trip planning, payment systems and assistance for people with disabilities. It also planned a "smart corridor" that connected underserved neighborhoods to jobs and services, smart traffic signals, smart street lighting, traveler information and payment kiosks, and free public Wi-Fi. These efforts led to Columbus winning the DoT's Smart City Challenge grant of up to $40 million, which attracted matches such as $10 million from Vulcan, the philanthropic vehicle of the late Microsoft co-founder Paul Allen.

Prioritizing the right goals is critical because it can have serious consequences. For example, life expectancy disparities are huge between Cleveland and its surrounding areas. "You take an eight-mile drive from Cleveland's neighborhoods of Lyndhurst to Hough, and life expectancy drops by 24 years," said Seeta Hariharan, general manager and group head, Digital Software & Solutions Group, Tata Consultancy Services. The same is true of London. "You take the tube from London's Oxford Circus to Silver Lane — the life expectancy drops by 21 years." That life expectancy gap occurs because of health disparities. "But health disparities don't occur unless there are also disparities in transportation, education, housing, food access and work force development," she added. "Smart cities must balance resources for the betterment

> **Facial recognition technology enables citizens to pay bus fares, sensors and renewable energy can power services such as trash pick-ups, and most City Hall services have moved online.**

of the basic needs of its citizens before taking on smarter parking."

One country way ahead on this effort is the Netherlands. In 2016, it became the first country to roll out a nationwide network dedicated to IoT that can connect millions of devices and sensors to the internet. Many applications use this network to deliver services to enhance the lives of citizens. "This has fueled development of working prototypes by the local companies like an application to control and monitor its extensive drainage and flood control infrastructure," Hariharan said.

Once goals are prioritized, it's important for municipalities to take an integrated, cross-cutting approach to building a smart city. One early goal would be to provide a single portal where citizens can access all city services. In a smart city, this could mean providing access through mobile devices or setting up smart street kiosks. Cities should aim to provide one common experience for users, whether they are seeking a license, pay taxes or report an open manhole. It becomes unwieldy if each city department had its own portal or app — be it garbage collection or water service. New York's NYC311 mobile app is one example, although several other U.S. cities have similar apps, as well as places like Yinchuan, China and Singapore.

An integrated model could extend beyond the apps level, as the cross-cutting approach applies at every layer of the stack. For example, the data underlying the apps could also reside on one platform that could talk to sensors installed by multiple city agencies. With one command, an administrator could communicate with the platform, which could then convey a signal with an instruction to any of the sensors connected to it. Common platforms could also anchor citywide data gathering and data architecture. Some U.S. cities are beginning to sign agreements with large companies to implement such platforms.

FOUR TECHNOLOGY LAYERS

Smart cities need to establish four layers of technology: sensors, networks, platforms and applications, according to the paper, "The development of smart cities in China," by Yongling Li, Yanliu Lin and Stan Geertman of Utrecht University in the Netherlands. The sensors gather the data, be it through RFID tags or QR codes, and the networks (TV, broadband and other communication channels) facilitate the transfer of information. The platforms are where all the information is processed, analyzed, secured and managed as it links to various applications that provide services such as tracking public buses in real time.

Singapore and China are further along on the platform path. Singapore launched SingPass in 2003, a gateway to as many as 400 city services that citizens could access with one login ID and password. Meanwhile, the city of Yinchuan in China's northwestern province of Ningxia Hui is among the most talked-about of the country's 500-plus emerging smart cities. Facial recognition technology enables citizens to pay bus fares, for example, without reaching for their wallets; sensors and renewable energy can power services such as trash pick-ups; and most City Hall services such as passport renewals or securing licenses no longer require face-to-face interactions, and have moved online. (With a platform approach, it is not necessary for all city departments and agencies to be ready for web interaction. They can get onboard to provide the same user experience when they are ready.)

Carbondale, a town of 25,000 people in Illinois, did not have a sophisticated work ordering system or tracking software. "Sticky notes were the most popular way of passing information back and forth, followed by phone calls and emails," according to SeeClickFix, a provider of apps that help city residents connect with the local government for a range of service requests. So Carbondale sourced a customized app from SeeClickFix in 2016 that let residents send service requests and report problems. It led to the city's public works department getting better organized while communication improved and brought more accountability to the city council.

Importantly, communication between the resident and the government must be two-way. For example, if a resident reports that there's a pothole in the street through a government app, ideally the city should ensure that when the work crew gets the job done, it flags that the hole is fixed and sends a picture of the repair to the person who reported it. "It's about building in this two-way conversation," Berst said. "It's not just about hearing from citizens or telling them — it's a dialog."

NAVIGATING POLITICS

Be mindful of the politics around smart city projects. Some cities may face few obstacles in implementing a smart solution for a problem, while others may face political or budget constraints. Duranton offered the example of San Francisco's SFPark parking system that uses a demand-response pricing mechanism that makes it easier for drivers to find parking spots and helps reduce congestion. "If the demand is for less than 50% of the parking spots, the price will be low, but when that crosses 80%, the price goes up; and when it reaches 90% it really goes up so that people don't need to cruise forever to find a parking space" because the cost becomes prohibitive.

SFPark aims to maintain occupancy of parking spots at between 60% and 80%, with rates going down to as low as 50 cents an hour in times of low demand and up to $7 an hour for high-demand times. It adjusts rates no more than once a month for each block. Launched in 2011 as a pilot project on 7,000 of the city's nearly 29,000 parking spaces, SFPark made its latest adjustment in January 2017 — the 20th such adjustment since launch. The project has been hailed a success with significant drops in distances traveled by drivers before finding a parking spot, and a decline in average parking rates they paid.

San Francisco's example is not easily replicable. Take Philadelphia's parking practices. "San Francisco is doing 'smart' parking and Philadelphia is doing 'dumb' parking," he said. "The issue is two-fold. One is a technical aspect; the other is a political aspect. The reason Philadelphia is doing 'dumb' parking is because there is a bad political economy associated with that, in the sense that fewer people in San Francisco own cars compared to a lot more in Philadelphia. In Philadelphia, car owners expect to be able to park for free or for [the resident parking fee of] $35 a year, which is just insanely low." His conclusion: "It's all very good to have technical solutions, but unless we understand the context and the politics around different issues, we can be pretty smart but that won't lead us anywhere."

A CHECKLIST FOR SMART CITY LEADERS

- Identify areas of priority, such as public safety and urban mobility.

- Apply the four layers of technology: sensors, networks, platforms and applications.

- Make sure there is two-way communication between the resident and the local government.

- Be aware of the political context.

Urban Planning and the Smart City

Urbanization is the primary reason today's cities have to become smarter in how they deliver their services. "Ten thousand people are moving to cities every hour of every single day, in places like Asia, Africa, and Latin America," said Seeta Hariharan, general manager and group head, Digital Software & Solutions Group, Tata Consultancy Services, during a recent speech on 'Smart Cities and Smart Behavior' at the University of Maryland. Even in highly developed countries like the U.S., she said, urbanization has grown by 19%, just in the last 17 years.

Urbanization is occurring globally for good reason, compelling enough for people to leave behind their hometowns and families. "Many are moving because they don't have access to basic needs [in their hometowns] — needs such as health care, education, sanitation, or decent jobs," Hariharan said. "If this trend of rapid urbanization continues, to sustain it, we would have to build a city as large as London from the ground up every month for the next 33 years."

As such, a city's urban policymaking should focus on solving specific problems that come with dense populations, such as congestion, pollution and traffic safety, rather than imposing blanket rules. "The blind application of one instrument — like a tax for vehicle-kilometers travelled or land use deregulation — to solve one problem (like congestion or housing affordability) may worsen other problems," according to Wharton professor Gilles Duranton and Erick Guerra, professor of city and regional planning in the School of Design at the University of Pennsylvania, in their 2016 paper, "Urban Accessibility: Balancing Land Use and Transportation."

That's not to say they shouldn't have a cohesive strategy. Getting the big picture right before introducing smart

transportation solutions is critical, Duranton said. "You can do smart street lighting, smart parking and what not, but I'm not sure all those add up to a policy on transportation. A policy on transportation, just like a policy on anything, must have a strategic element to it." That calls for the combined expertise of both the engineer and the economist, he said. "You need a strategic decision on what sort of a city you want to be, what kind of transportation you want, and what sort of local economic development policies you want, if any."

Duranton and Guerra urged cities to prioritize the accessibility of movement, or the ease by which residents can reach their destinations. "Accessibility is the main urban quantity to consider from a resource allocation standpoint since it links land use and transportation, the two primary urban consumption goods." They said policymakers often ignore, misuse, and misunderstand accessibility. The result is the inequitable and inefficient misallocation of the two most important urban consumption goods — housing and transportation access.

However, a number of conflicts could still arise. For example, there could be tradeoffs between land use, transportation and other public amenities like open space or the quality and character of a place. "We understand that one city's residents may favor economic development when another favors historical character and amenities," Duranton and Guerra said. The best approach to solve those problems is to approach them one by one, "improving policy at the margin, rather than determining an ideal and setting policies to resolve it."

BELFORT VS. PARIS

The city of Belfort in France adopted smart strategies to connect its bus transportation network, Hariharan said. Belfort achieved a "remarkable" feat recently when it turned its entire bus network into a 'smart' system in just four weeks and without deploying a single new sensor. Belfort achieved that rapid transformation by bringing together existing data to generate new information.

The city got 'smart' via data analytics based on information already accessible to planners. It brought together data sources such as bus billing, ticketing data and GPS systems, which in turn allow city officials to make informed decisions to improve services on the city's five bus routes. For example, the software works out the speed of buses between each stop to identify congestion points and allows the city to make any appropriate changes.

Paris is at the other end of that 'smart' spectrum with its transportation policies, according to Duranton. In 2001, Paris introduced regulatory changes that reduced the road space available for vehicles in order to slow down vehicles.

However, it was not offset by increased patronage of bus travel by residents or by increased bus speeds. "The policy generated a considerable time loss for car users and for goods delivery vehicles, and even environmental losses, without gains for public transport users," according to University of Paris professors Rémy Prud'homme and Pierre Kopp in the book "Road Congestion Pricing in Europe."

"Paris is unsmart with its transportation policy in that it is tearing down all its arterial roads," said Duranton. "There is this notion that cars are a problem — they create accidents, pollution and congestion. But the solution is not getting rid of cars and [think] everybody will be perfectly happy driving their bikes or whatever. That is not the answer for a large city like Paris."

URBAN PLANNING IN INDIA

Shortcomings in urban planning and governance structures could have long-term repercussions, not just resulting in haphazard development but also in welfare costs for the less privileged. However, those effects could be mitigated to some extent with investments in public transportation, updated laws and regulations and corrective planning actions, according to Wharton professor of real estate Mariaflavia Harari. She recently spent time doing research in India, which resulted in her December 2016 paper "Cities in Bad Shape: Urban Geometry in India."

Harari's findings point to a wide range of policy options to improve urban mobility and prevent the deterioration in connectivity that fast city growth entails. For one, urban mobility can be enhanced through direct interventions in the transportation sector, such as investments in infrastructure and public transit. Second, urban connectivity can be indirectly improved through more compact development, which in turn could be encouraged through master plans and land use regulations.

One important measure in urban planning is the floor area ratio (FAR) — or floor space index (FSI), the term for it in

India. That determines the extent of vertical development permitted on a given piece of land. In many U.S. cities, development tends to be denser in the center of the city and then it tapers down progressively towards the cities' peripheries. However, in India, Harari noticed more high-rise buildings on the outskirts of cities like New Delhi. The chief reason is that enforcement of regulations is lax in areas outside city limits, although they are very much a part of that particular urban agglomeration. "In India you have a contrast: very tight regulation in the cities and relatively less stringent regulations or less clear planning in the periphery of the cities," she said.

Haphazard development leads to distortions in costs. In her paper, Harari attempts to quantify the costs borne by people living in a city with "non-compact layouts." She wrote that connectivity refers to a city that has a geometric layout that is conducive to shorter trips. Her study of rents in cities with varying degrees of connectivity revealed that households pay a premium to live in cities with better connectivity. "People are willing to pay 4% of their income in order to live in a city that has better connectivity," she said.

A city with compact layouts expands in circles as opposed to expanding in all directions. For example, in the Indian city of Kolkata, development is elongated along the north-south axis and narrower along that axis, as opposed to Bangalore where development is roughly like a pentagon, and more circular. "The average distance between any two points in Bangalore is shorter than it is in Kolkata," Harari noted, adding that her methodology accounts for the geographical attributes of a city that might allow it to grow more along the north-south axis or in concentric circles.

To be sure, regulation also plays an important role. "Cities with more restrictive FARs, all else being equal, end up taking less compact shapes," said Harari. Outdated laws also skew development in wrong directions. Harari found "no correlation" between earthquake-proneness and FARs in Indian cities, although it would be obvious to planners to avoid tall buildings in areas that are vulnerable to earthquakes. Instead, she saw a connection elsewhere: Cities with more restrictive FARs were those that were directly under British rule, which ended in 1947. Her conclusion: "That is partly explained by the British urban planning paradigm of low density, and then that stayed on because those laws have not been changed."
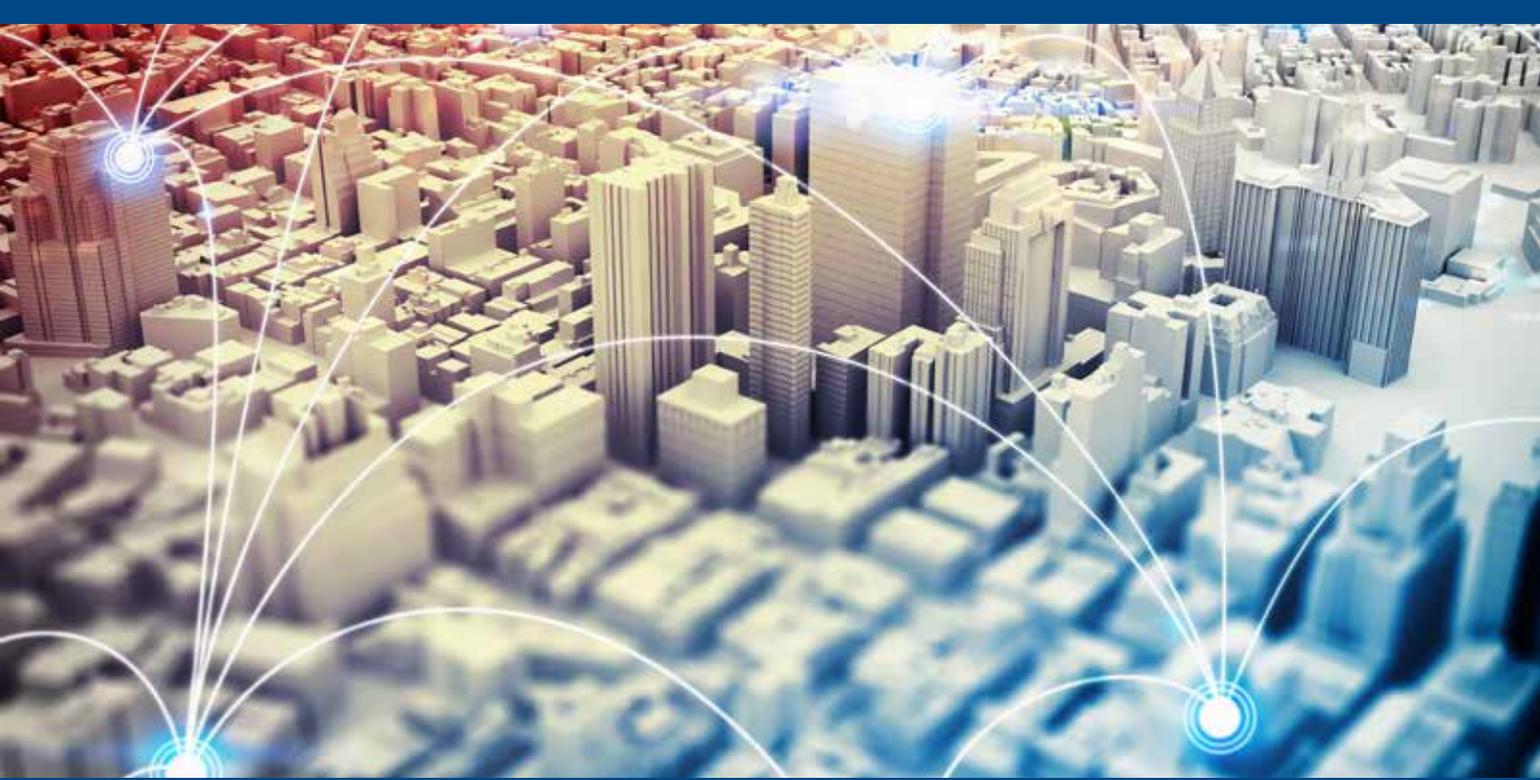
Using City Data to Develop Innovative Solutions

Every time you drive past a traffic light, pay a bill, call a city department, search the city website, or even throw out trash in your neighborhood dumpster, you create data that is collected by your municipality or its private sector partner. Applying data analytics to this and other data points collected from fellow residents enable city administrators and their partners to provide better service — faster responses and more cost-effective solutions that can anticipate your needs.

Data gathering and analysis are underway in many municipalities. Chief data officers are building open data portals that they share with their counterparts elsewhere to create centralized "data ingestion engines" that take information from multiple sources. Los Angeles, Chicago, San Diego and Atlanta are creating such open data portals. Moreover, they are building datasets and application programming interfaces (APIs) — a set of definitions, protocols and tools that help programmers create software — and sharing those within their own departments and third parties like tech startups, who would then create apps based on the data.

Such an approach helps dramatically unleash latent potential in the data for use by data scientists, a city's

Chief data officers are building open data portals that they share with their counterparts elsewhere to create centralized "data ingestion engines" that take information from multiple sources.

in-house operations, professional software developers, college students, entrepreneurs and incubators, said Austin Ashe, general manager, intelligent cities at GE's subsidiary Current, which calls itself the digital engine for intelligent environments. "It lets them have a chance at building an interesting use case or an interesting outcome using the data."

Here, the U.S. government leads by example. Its data resources are available at data.gov/open-gov. For regional and local governments, data are available at cities.data. gov, counties.data.gov and states.data.gov. San Francisco,

Philadelphia, New York and Seattle lead the list of cities that have put out the most number of APIs and datasets, according to an AT&T blog for software developers. They have spawned apps for all manner of citizens' needs. New York's portal, for instance, has an app designed by its health department for "cooks from all walks of life," while other apps help locate drinking water fountains or parking spots.

Waze, a traffic and navigation app owned by Google, is a prominent example of an innovation that uses public traffic data. Drivers use the Waze app on their smartphone to navigate their trips better by avoiding accident spots and congested roads. They also interact with other drivers by giving them a heads-up about police sightings, road hazards and other trouble spots on their trip. Waze has partnered with 72 U.S. cities including Los Angeles, Boston and Jersey City, N.J.

The availability of open data in vast amounts and in accessible formats, and the analytics it allows, enables city departments to leverage each other's data and also collaborate, breaking down silos that have traditionally existed between them. For example, half a dozen different city departments or agencies could find parking data useful to do such things as oversee traffic, gather revenue from parking ticket fees, street cleaning, and so forth. At the same time, a food truck owner could use data on open parking spaces and dynamic pedestrian movements to decide on the perfect location. "That's the magic of smarter cities and IoT platforms right there, with the simultaneous use of historical data and real time data," Ashe said.

But former Atlanta CIO Samir Saini thinks cities in Europe are ahead of those in the U.S. in aggregating and sharing data across various departments and with outside groups, such as universities and companies. "That means being very deliberate about the use of data and the contracts we sign with vendors that have smart city solutions," he said, adding that Atlanta is going about that approach consciously.

THE FIVE Cs OF DATA SHARING

Saini identified five groups — the Five Cs — that benefit from such an integrated and collaborative approach. The first 'C' is where the city departments themselves are the users and the customers of the platform. Different city departments use each other's data so that there are truly no silos when it comes to data filed across departments within the city. For example, the water utility may buy a smart water meter that has a "smart water cloud" with consumption and other data that might be valuable to other departments — something previously not being shared. That approach in itself could create real value with improved service delivery to citizens.

The second 'C' is for citizens, where the city takes a citizen-centric, and not a department-centric approach. That means citizens receive a unified platform for say, paying a water bill or securing a business license — an activity that typically requires multiple departments to be involved. The government interacts as one entity with its citizens, bundling all services on one dashboard. In order to accomplish that, the city needs an open data platform "that brings it all together," such as OpenGov — a cloud solution for public sector budgeting, operational performance and citizen engagement.

The third 'C' is the college/university system. The city extends its data platform through formal relationships with its "best and brightest" colleges for R&D projects that might produce solutions to city issues. In Atlanta, for example, the city shares its data platform with Georgia Tech and is collaboratively working on multiple projects, including one in advanced data analytics.

Community impact is the focus of the fourth 'C' where the city extends the data platform to the neighborhood level for services and apps. For example, it might want to provide "situational awareness" of the state of health or public safety in their neighborhood to both communities and city administrators. They would slice and dice the data to try and find solutions to improve the outcomes on these fronts.

The fifth 'C' has firms in the "civic tech" space that work on technology solutions for city services, and the larger business community. They would use the APIs that the city publishes to develop apps or other products. The city would also gather APIs from other entities such as transportation agencies, and act as a "clearing house" for APIs, providing tech firms and others access to a wider group of APIs. "The fruits of those efforts would be felt beyond the city, across the region and also across the state," said Saini. He noted the potential for Atlanta: It has 4.9% of the state's population but contributes 59% of the state's economic output.

One example of how IoT sensors could do forecasting analytics, although not predictive analytics as yet, is their deployment in Atlanta's sewer system. The city has a combined sewer system where storm water and wastewater run through the same pipes. It also has an aging pipeline system, and so it frequently faces "combined sewer overflow events." The city's water department recently implemented an IoT project where it deployed sensors on manholes to measure flow levels. During a storm, if the flow levels hit a certain threshold, alerts are sent through a visualization tool to allow a dispatcher to send teams out to address the overflow before it worsens. "This enables us to respond to the event, so that we can manage it in a proactive versus a reactive manner," said Saini.

Other cities too have launched projects to systematically share their data across departments and entities such as colleges/universities, civic tech firms and other businesses. However, before a city determines how its various agencies can cross-reference data and share datasets, it needs to understand the data it already possesses. In an ambitious move, Washington, D.C. is cataloging the existing data in each of its departments and agencies and complete the project over the next year. That would give it an understanding of the types of data it has, the formats in which they are collected and stored, and the frequency of their collection.

CHALLENGES AROUND DATA SHARING

Data sharing efforts have their share of challenges, too. One persistent question for cities and citizens is how the data is managed, who owns the data, what standards should apply, and what they should they do with it, said Britt Harter, director of sustainability services at PricewaterhouseCoopers. "There certainly is an emerging interest in monetizing that data, and in no small part because cities are very cash-strapped."

As cities view their data as a potential revenue-generator, they must tread with caution. The primary issue is that of privacy. "If and when the city is seen to be selling information about its residents that is sensitive — who are its stewards and what would be a breach of trust?" asked Harter. "I caution the drive to monetize the data, to counterbalance that with managing the trust of residents." Helpfully, the Smart Cities Council's Open Data Guide lists 17 universal principles that apply across all partners, and one of that covers citywide data security and privacy.

In many cases, cities are able to anonymize data that could be of value, without compromising citizens' rights, Saini noted. For example, counting the number of pedestrians is important to economic development groups, retailers and building owners because it helps determine whether to establish a retail store or an apartment complex in the area. Similarly, data on the number of cyclists on the streets could be useful for bike-sharing and ride-sharing firms. He said data that is so counted tends to create "a sufficient level of anonymity."

THREE PILLARS

As mayors delve into smart city development in earnest, it's good to look at the effort through three pillars. The first "is to recognize that you can unlock innovation locally," Ashe said. "We at GE like to think of smart cities through the lens of IoT." He added that the concept of smart cities has changed over the past 10 to 15 years from its traditional

A CHECKLIST FOR SMART CITY LEADERS

- Build open data portals to share with other cities to create centralized 'data ingestion engines.'

- Leverage the vast amounts of open data and analytics to help city departments remove silos and collaborate more closely.

- Remember the five 'C's of data sharing: city departments, citizens, colleges, community impact and civic tech.

- Be a trusted custodian of citizens' data, even as revenues from data monetization beckon.

- Look at smart initiatives through three pillars: unlock innovation locally, find and execute on opportunities and bring a sense of urgency to the task.

sense of helping City Hall deliver services better on its own to "it's no longer the mayor and the staff trying to figure out how to solve problems."

Rather, engagement with the broader community of citizens and other stakeholders is an integral part of the new order. In that changing civic engagement model with the broader community, opportunities abound for innovation to occur with "extremely fast and scalable methodology" through IoT. Participants in those endeavors could be universities, entrepreneurs or ordinary citizens. As such, the second pillar is to have a city leadership team dedicated to thinking about and executing on those possibilities.

The third pillar is about bringing a sense of urgency to these opportunities. Today's cities are changing at an extraordinary pace in terms of citizens' needs and demands. Yet, the traditional way city administrations go about their business is too slow, chiefly because that was how they were set up. They have to be more flexible on what changes they need to make, what their citizens need, and how they will go about delivering on those needs.

Finding the Money for Smart City Initiatives

> **"Finding funding is one of two key challenges when it comes to implementing smart-city strategies, and the other is technical capability."**
>
> —2016 Smart Cities Council survey

Finding funding is one of two key challenges when it comes to implementing smart-city strategies, and the other is technical capability, according to a 2016 Smart Cities Council survey of more than 400 U.S. municipalities and state governments. Indeed, ask any city official about the biggest worry relating to smart projects, and most likely inadequate financial resources would be top of mind. Municipal budgets typically have little or no slack to allow for smart endeavors. And raising taxes to pay for it is usually not an attractive option, unless it is spearheaded by advocacy programs and the benefits are credibly articulated to residents.

As such, city administrations have to be creative about their finances, whether it means repurposing existing allocations, forging public-private partnerships with private investors, or cutting the costs of existing services through more efficient procurement policies. Wharton professor of finance and economics Robert Inman said there are ways for cities to get the biggest bang out of every taxpayer dollar. Since labor usually is the biggest cost, the city should make sure that labor costs are competitive for providing city services like education, police, fire, sanitation, health care and the like. On the revenue side, the city ought to levy taxes to closely approximate the benefits the taxpayer receives in the way of services.

George Atalla of consulting firm EY said municipalities are often "struggling" with finances because of a variety of reasons. Federal government funds for smart-city projects tend to be small relative to the need since these funds have too many claimants. Cities collect much less revenue by way of taxes compared to the federal government and their ability to raise more is limited. They face several constraints as well when it comes to getting funding from the private sector for city projects.

Monetizing the data that cities provide third parties through their APIs or datasets is an attractive opportunity to raise funds. However, no uniform approach is available for what data to share publicly, how much would be free and how much they would charge for the rest. Austin Ashe, general manager, intelligent cities at GE's subsidiary Current, cited the example of a lender or a property developer getting access to data on foreclosed houses in California's Bay Area from the county courthouse. The county might levy a fee that covers the costs of providing those records. But when somebody wants "extraordinarily granular information," say about traffic patterns or pedestrian movement or environmental patterns or public safety, "just because it's open doesn't mean it's free," he added. "Cities will start working through policies that help them determine when to charge and when to just make it available to them and to the general public for free."

To be sure, municipalities have decades of experience sharing revenue with private investors that fund public projects, such as an independent power plant. Atalla noted that "every country knows how the contracts are written; the private sector partner comes in and gets a long-term contract, and a share of the power that is produced. The whole scheme of the revenue stream has been sorted out."

Compare that to a smart-city initiative, which does not readily offer an underlying asset that could serve as collateral to secure the financing, and thus might find it harder to get a backer. These are projects such as the deployment of sensors to manage traffic better, or installation of cameras for improved monitoring to ensure public safety, or putting sensors on trash bins to decide the right day to collect garbage and optimally route trash trucks to reduce costs, congestion and pollution.

Atalla said cities can get around those challenges by linking the payment to performance or the savings that the project achieves. For example, if the city can better manage its solid waste with sensors and algorithms to guide trash trucks, it would generate some savings. The city could come up with a plan to share those savings. Similarly, if the city is building more efficient roads and using sensors, it could find ways to measure the travel time saved and congestion avoided, quantify the results, and provide a share of it to the private-sector partner.

Sharing the savings with private sector partners is the most popular choice, according to Atalla. That method is used for services such as street lighting, traffic control and solid waste management because it is harder to measure their performance outcomes. That's not to say that an economist would not be able to quantify the economic impact of time saved in traffic, he said.

> ## "Anyone who approves a lot of money is going to take a lot of pressure for the approval, and it is important that what you get in return is seen as equally valuable."
>
> —BRITT HARTER, director of sustainability services, PricewaterhouseCoopers

Although examples are few of investors sharing in the outcomes from smart-city projects, Atalla pointed to models that have worked in other areas such as the rate of recidivism, or the number of ex-convicts who return to prison. The private sector partner that provides related services to felons such as education, employment training, counseling and so forth gets paid by an amount equivalent to the reduction in the number of people returning to jail. That method is called "pay for success," or PFS, where projects are financed by so-called social impact bonds.

The first PFS project was implemented in 2010 by the HM Prison Peterborough, outside London. The project envisaged savings in the cost of running the prisons, and it offered investors a specified return for a 10% drop in the re-conviction rate over five years. Some 17 foundations financed the social impact bonds totaling £5 million ($6.6 million), but the drop in the re-offending rate fell short at 8.4%, according to a study of the project's first phase by QinetiQ and the University of Leicester. Prison systems in the U.S. also have attempted such projects financed by social impact bonds, but have faced challenges in quantifying the outcomes.

Britt Harter, director of sustainability services at PricewaterhouseCoopers, said it is not easy for a city to create sufficient support for intangible or long-term benefits. "Anyone who approves a lot of money is going to take a lot of pressure for the approval, and it is important that what you get in return is seen as equally valuable," he said. Often, disconnects exist on what that value is between decision-makers and the general public or experts. "Therefore, finding a way to create sufficient excitement and engagement for those less prominent or intangible benefits is important," Harter added. "The right revenue lever is an open question — is it going to be financed by new taxes or by reallocation of existing funds? There is a lot of creative work that goes on with budgets in cities, but I don't know if anyone has found a fully reproducible model."

Governance issues also come into play and bring obstacles, Atalla said. For example, the mayor does not control the electricity provider, and so he or she is not in a position to demand better service. Similarly, the mayor also does not have direct control over the city's department of transportation, and so persuading it to invest in better technology to reduce congestion is also a challenge. "The department of transportation might prefer to go out and build more roads."

STRONG PROJECTS LURE INVESTORS

Notwithstanding those financing obstacles, projects with strong business cases do attract funding, as demonstrated by a much-cited project in Columbus, Ohio. The city's plan for investments in connected infrastructure, electric vehicle charging infrastructure, an integrated data platform and autonomous vehicles won the 2015 U.S. Department of Transportation's Smart City Challenge grant of $40 million. A total of 78 cities participated in that challenge, and the runners-up included Austin, Tex., Denver, Kansas City, Mo., Pittsburgh, Portland, and San Francisco.

A central feature of the Columbus project was to be inclusive by benefiting a broad swath of its citizens, such as reducing infant deaths by improving transportation to medical care. Other investors lined up after it won the DoT challenge: Microsoft co-founder Paul Allen's philanthropic vehicle Vulcan Inc., which wants "to tackle the world's toughest problems," gave Columbus up to another $10 million. The city also got $90 million from other private investors for its smart-city projects.

Columbus committed to collaborating with the runner-up cities, and sharing best practices from its projects with other municipalities. All that encouraged more funding for smart-city projects elsewhere: In 2016, the Organization for Economic Cooperation and Development committed grants totaling $65 million for community-driven transportation projects in U.S. cities that use advanced technology. The resulting enthusiasm encouraged other cities to raise some $500 million from public and private investors.

The LinkNYC project in New York City is another example of an innovative financing model. Launched in 2014, the project goal is to bring free wireless internet coverage by repurposing some 7,500 old payphones in the city's five boroughs over eight years. CityBridge, a consortium of investors that won the 12-year contract, is investing $200 million to install fiber and deliver gigabit-speed internet, which is about 100 times faster than the average public Wi-Fi. The 'smart kiosks' that replaced the old pay phones offers free phone calls to anywhere in the U.S. through a tablet, including access to 311, 911 and 411; maps and directions; USB charging ports and an encrypted public Wi-Fi network with customer privacy features built in.

The LinkNYC project is not financed by New Yorkers. CityBridge funds it entirely from advertising revenues, and shares half of that with the city government. Over a period of 12 years, the city would earn more than $500 million from the project, according to estimates. At last count, CityBridge has set up 1,200 smart kiosks across the city, according to Jeff Merritt, former chief innovation officer of New York. "The top achievement is the innovative business model and contract structure that incentivizes the service providers and vendors," he said at the Smart Cities Week conference in October 2017.

"The LinkNYC model works because the city is trading something that it controlled that was valuable in exchange for services that were valuable," added Harter. "If a city is looking to do something where it has nothing to trade or sell, that is when it can get to be more challenging."

ANOTHER USE FOR STREET LIGHTING

Repurposing existing assets in smart ways could allow cities to implement innovative projects. For Austin Ashe, general manager, intelligent cities at GE subsidiary Current, the street lighting infrastructure in a city has big potential. A city usually has between 10,000 and 300,000 street lights. These are valuable assets because they're everywhere and they already have a power supply built into them. They also have a unique elevation of about 30 feet or 10 meters.

"We saw an opportunity there to repurpose that infrastructure by creating essentially a smartphone-equivalent that can sit on that street pole," said Ashe. Many cities that want to go smart tend to install sensors on more than a dozen disparate systems — one each for smart parking, smart traffic, environmental management, pedestrian safety or gunshot detection and so on. All of these consume large amounts of time, energy and money

to procure, install and manage. Consolidating them on streetlights, in one device and one platform is what smart street lighting delivers, in addition to cost and time savings, he added.

This digital infrastructure on streetlights also provides "a flexible smart platform" on which to build apps, Ashe said. For example, it could have an operations application for the police force around gunshot detection, or for the traffic department to use data analytics to ease congestion, save energy and increase public safety with dynamic operations, where sensors detect the need to turn on lighting. Apps could help citizens do such things as find open parking spaces or report a problem. The data extracted from these smart street lights can be leveraged through APIs that combine city operations with citizens' needs to build applications.

While cities grapple with their funding challenges, larger issues sometimes seize the agenda. Atalla referred to a larger debate underway in smart-city circles on the sharing of powers and responsibilities between the city and the central government. "Regardless of which country you are in, people identify themselves more with their cities then with their country," he said. For example, people living in Dubai associate themselves more with the city of Dubai than with the country, the United Arab Emirates. That sentiment creates conditions for turf battles. "You pay taxes to the central government but the city is in the frontline of providing services."

A CHECKLIST FOR SMART CITY LEADERS

- Be creative about funding, whether it means repurposing existing allocations, forging public-private partnerships, or cutting the costs of existing services.

- Monetizing users' data is an attractive opportunity to raise revenue, but be mindful of privacy issues.

- Share the savings or quantified performance outcomes from smart-city projects with private-sector partners that fund them.

- Look to repurpose existing assets for innovative projects.

Refining Procurement Processes for Big Gains

> **"The biggest pain point that cities are starting to address now or come up against is procurement."**
>
> —DOMINIE GARCIA, smart cities program lead, Battelle

While finding the funding for new projects is often one of a city's biggest challenges, how well those monies are spent is equally important, as it has implications for the balancing of city budgets, provision of services to citizens and crafting of tax policies. In smart cities or smart states, procurement, which includes activities such as purchasing of goods and services, writing the specifications, calling for and evaluating bids, is a continually evolving function.

City administrators constantly grapple with issues that hinder efficiencies in procurement. Limited staff resources and time constraints are common obstacles. Contracts expire regularly for purchasing supplies that need to be replenished. If time is a constraint, such as a rush to spend an allocated amount by the year-end deadline, officials have to decide whether they realistically can float an RFP (request for proposal), invite bids, evaluate them and award a contract in good time.

"The biggest pain point that cities are starting to address now or come up against is procurement," said Dominie Garcia, smart cities program lead at Battelle. "Their procurement processes are slow and cumbersome, and beholden to a lot of legacy contracting and policy rules and processes that may not be appropriate for very quickly developing and evolving technology."

BENEFITS OF COOPERATIVE PROCUREMENT

Cooperative procurement is one solution, according to Tammy Rimes, executive director of the National Cooperative Procurement Partners, a nonprofit association of procurement professionals. Here, a city could piggyback on another city's contract for similar products or services further along in the procurement

process or already awarded. The addition would be entitled to the same price and other terms of the contract. U.S. law permits cooperative procurement. Of course, cities have to do their own due diligence and legal groundwork beforehand.

Rimes listed other areas where cooperative procurement could bring benefits. One big plus is that it helps cities leverage the gains of bulk pricing as orders from multiple agencies are bundled together. It is especially useful in the provision of emergency services, such as in the procurement of fire extinguishers. It also serves as a 'gap filler,' when a city needs an item that is not covered by an existing agreement and it cannot justify going through a time-consuming bidding process to get it. Also, some orders are too small to invite bids. "A purchase order costs $167 on average. What do you do if you need a $50 part?" asked Rimes. Here, the city could piggyback onto the contract of another city that has ordered the item.

Cooperative procurement is especially useful for maintenance contracts, such as for vehicles or other equipment. In many cases, cities enter into multiple maintenance contracts for equipment they may have bought at different times, such as electronic equipment. That clearly leaves room for wasteful expenditure. "Maintenance contracts are money spent every year but not really managed," said Rimes. "This is an invisible expense." In a presentation she made at the Smart Cities Week in October 2017, she offered the example of the University of California, which recently consolidated equipment maintenance contracts across its educational system. Early results in a pilot program at one of its 10 locations — the University of California, San Francisco — showed savings of $257,000. University-wide, the potential annual savings are a projected $30 million.

In one model similar to that of cooperative procurement, states come to the aid of their cities. In Illinois, the department of information technology floated an RFP in January 2017 for a statewide smart street lighting requirement. Once that contract is awarded, it will allow all city municipalities across the state to use it for their requirements, without having to renegotiate prices or other terms.

OUTSOURCING AND JOB-ORDER CONTRACTS

Outsourcing select services such as inventory management could also bring big savings to cities or counties. Here, one case Rimes cited was that of the County of Salt Lake in Utah, which implemented a fleet inventory management system for some 4,000 pieces of equipment, from chain saws to fire trucks. Instead of owning and managing a large inventory of parts worth between $700,000 and

The County of Sacramento in California has demonstrated gains from job-order contracting since 2003, and has been able to roll out projects in four to six weeks instead of the normal four to six months.

$800,000, it wanted to pay for parts only when it needed them, and brought down its inventory carrying cost to zero. The county outsourced to a third party, and sharply cut the number of monthly invoices from 3,000 to 4,000 to three or four. Moreover, it raised productivity and eliminated the obsolescence of parts that would occur in its own warehouses. "Most cities have a warehouse with all those parts," said Rimes.

Another way out of conventional procurement practices is job-order contracting. Here, a city would go through the usual solicitation process, but set up a contract in advance so that whenever a job comes up — fixing a leaky roof, for example — the service can be procured without loss of time. "I can have the contractor walk the job with me, and agree on the scope and price catalog," said Rimes. The County of Sacramento in California has demonstrated gains from such job-order contracting since 2003, and has been able to roll out projects in four to six weeks instead of the normal four to six months. Job-order contracting is ideal for small projects, emergency work and repetitive work.

WHAT VENDORS GET WRONG

Procurement officials in cities often encounter disconnects with vendors of goods and services. Vendors try to sell their wares without trying hard enough to understand the broader issues that cities face, according to Hardik Bhatt, who until recently was the CIO of the state of Illinois, and previously served as CIO of Chicago. Bhatt has led several smart-city initiatives in Chicago and at the state level as well. "Vendors could also share ideas in helping city or state administrations overcome some commonly faced challenges in introducing new technology such as with regulation and procurement," he said. Vendors sometimes do not spend enough time to understand a city's problems. Usually, "vendors try to take their solution and fit it onto a problem. They will tell me, 'This is my solution. Let's see if you have a problem that I can help you solve,' as opposed to, 'Tell me what your problems are, and let's work jointly to find solutions.'"

Secondly, especially in the smart-city or smart-state space, cities are tackling large initiatives like smart street lighting

A CHECKLIST FOR SMART CITY LEADERS

- Involve the procurement department in purchasing decisions from the beginning. It gives them time to arrive at efficient solutions.

- Piggyback your orders on contracts negotiated by other cities or states in select cases. You get the benefits of bulk pricing and also save time.

- Identify small projects, emergency work and repetitive work. They may benefit from job-order contracting.

- Scrutinize multiple maintenance contracts for equipment. They are often candidates for consolidation and cost savings.

- Avoid warehousing parts and components of equipment, which have inventory carrying costs. Outsource to a third party and pay only for what you need and when you need it.

or smart trashcans. These are often not broken down into smaller pieces for the municipality to take on. Instead, the recommendation is a broad shift such as infrastructure changes and creating citywide Wi-Fi. Remember that governments can change based on their election cycle. Try to see what can be done within two or three years and then create some sustainability that can withstand a potential change in the administration.

Here are some questions to answer: How do you identify the regulatory changes that have to be made to accompany new initiatives? How do you finance these large projects or show ways to finance them? How do you, as a government, overcome the procurement challenges you face? When vendors approach city officials, ask them to answer these questions, not merely to sell their technology.

It is also important that vendors speak "the same vocabulary" as the mayor as they make the business case for a particular investment. "The business case must have something that the mayor or the governor could use to sell it to their own stakeholders," said Bhatt. "They have to sell it to their legislatures, their constituents, their departments, unions and others."

However, some issues that dog the public sector procurement function do not have easy solutions. According to Rimes, the average procurement official in government is more risk averse than his or her private sector counterpart. That will be an impediment to procurement and it can slow down the process. It also creates a little bit of "a paranoia factor," she said. Rimes listed the typical concerns in the procurement official's minds: What will be the public perception? If this came out in the newspaper, how will it look? Will it be challenged in a court of law?

All said, the size of the opportunity is huge to make government spending more efficient. State and local governments in the U.S. spent $2.7 trillion on procurement in 2014, according to Rimes. Of that, local governments such as cities, townships, counties, school districts and special districts accounted for $1.5 trillion, with states making up the remainder. Together, states and local governments will spend $3.7 trillion annually by 2024, she projected.

INVOLVE PROCUREMENT EARLY ON

In general, government procurement in U.S. cities goes by the book. "We have very strict rules and regulations regarding public procurement," Rimes said. "That is why people often complain that we are so slow. We have to be transparent, open to competition, etc." At a national level, procurement professionals generally follow guidelines set by the Universal Public Procurement Certification Council, a certification agency. At state and city levels, procurement rules and regulations vary, such as on spending limits for procurement officers. For example, Rimes had contract signing authority for up to $1 million in San Diego, Calif.

Purchasing departments may end up being blamed for delays or other lapses that occur because they were not involved in the process from the beginning, may face pressure to rush through orders, or if they were bypassed by other departments. The right way, of course, is to involve the procurement department from the beginning in making purchasing decisions. That would allow the procurement department to do the necessary research and follow the rules. "Many times they are not included in the … meetings in the mayor's office," said Rimes.

When journalists report on government lapses in procurement, it is because an end-user department that was not properly trained in procurement made the unfortunate decision, Rimes added. "Purchasing is usually the one team that can keep you out of trouble, keep you out of the newspaper and help you get what you need," she said. "They're a crucial member of the team, but are sometimes seen as transactional, rather than being strategic and proactive."

Tackling Governance Issues in Smart Cities

Municipalities tackle governance issues of all kinds, and a smart city brings its own set of challenges. But metrics-driven city organizations with a commitment to transparency will aid in that effort by ensuring a stronger adherence to a smart city's goals and principles. In addition to suitable governance policies, compensation structures with the right incentives and deterrents would ensure that city services are rendered in line with the desired specifications and within budget.

> **Metrics-driven city organizations with a commitment to transparency will aid in that [governance] effort by ensuring a stronger adherence to a smart city's goals and principles.**

INCENTIVES AND METRICS

How could a city best build incentives into its governance structure? To be sure, there is no panacea because different cities have different employment, labor, power and compensation structures, said Britt Harter, director of sustainability services at PricewaterhouseCoopers. Therefore, it is important that those incentive mechanisms are customized according to a city's needs. One way is to incorporate performance metrics into the positions of public officials to make sure they deliver.

For example, in Los Angeles, Mayor Eric Garcetti ensured that progress metrics for the "Sustainable City pLAn" were written into the job descriptions of department heads. "That moved the responsibility into the departments," said

Harter. It worked. The 2015 plan had set short and long term targets in 14 categories related to the environment, economy, and equity — including water conservation, clean energy, waste, green jobs, transportation, and livability. In March 2017, Garcetti released the second annual report of the plan's progress. Achievements included the creation of 20,000 new "green jobs" and ensuring that more than 80% of all city fleet procurements were electric vehicles.

San Francisco is another example of how these metrics work. The San Francisco Performance Scorecards make available to the public all data-driven assessments of government services and overall city performance. Those scorecards cover eight service areas: public safety, public

> One concept that is gaining popularity is open data dashboards that make metrics public, often in real time. These could be wait times at the Department of Motor Vehicles or the number of times sewage spills or accidents occur on any given day.

health, livability, safety net, transportation, environment, economy, and finance. These go into considerable detail to ensure transparency. For example, it discloses the names of city and county officials of San Francisco with whom a lobbyist made contact; lobbyists who register with the Ethics Commission are required to disclose those contacts monthly.

Harter pointed out that two important types of metrics apply in a city, and that they have to be balanced. One is to track the process or activity and the other is to measure the outcomes. In the first case, the idea is to make sure that activity is occurring — permits have been issued, data requests are being circulated and so on. These metrics are typically within the control of city departments and so "they tend to be more accepting of those metrics because they feel that they are manageable," he noted. The challenge is with "outcome metrics," which measure the changes in the experience of city residents. Harter said these are a little more difficult to implement because they are outside of the purview of the departments, and individuals are less willing to sign up for them.

One concept that is gaining popularity is open data dashboards that make metrics public, often in real time. Those could be the wait times at the Department of Motor Vehicles or the number of times sewage spills or accidents occur on any given day.

Transparency through the use of dashboards is at work in San Jose, Calif. The city has developed a "Smart City Vision" that defines broad outcomes in five domains: "To make San Jose as safe, inclusive, user-friendly, and sustainable as possible, and demonstrate the possibilities of technology and innovation along the way." It extended its transparency requirement to the newly created Office of Civic Innovation that works on broadband, smart-city projects and e-governance issues.

Digitization of government services such as in communication or e-government activities is another growth area. It offers residents the option of, say, taking a

picture of a road sign that has fallen down or a pothole and sending it to the applicable city department using a 311 app. (311 is a non-emergency number many city residents in the U.S. can call to get information about government services, report problems or make complaints.) They could also use apps for other services like filing business registrations or paying taxes.

These approaches save money, reduce processing times, make filing and data management more efficient, among other benefits. "They usually have a pretty good RoI (return on investment), and are easy to justify internally, so they are getting great momentum, and the smartphone is powering them tremendously," Harter noted. However, challenges remain in getting all those features on one common app, and "in a clean and manageable fashion," he said. "That reflects the challenge of coordinating many large and diverse departments, especially for many of these smart-city offerings that require different departments to work together and share information."

WORKING WITH FEDERAL OR NATIONAL GOVERNMENTS

But however forward-thinking a city wants to be, the reality is municipalities often find themselves at odds with state, federal or national governments when it comes to making decisions. "The policymakers making decisions that affect cities are typically not accountable to the citizens of that city, just because of the governance structures," said Wharton professor of real estate Mariaflavia Harari. Her advice: Vest city administrations with more decision-making powers over their citizens.

Multiple jurisdictions making decisions on city infrastructure and city services naturally create confusion. For example, New Delhi is a state with its own government, but because it is the seat of India's central government, law and order is outside its purview — the central government controls that portfolio. It also borders the two states of Uttar Pradesh and Haryana, which means some of its development activities spill over to those two states. Although New Delhi has its set of urban development regulations, the areas that fall immediately outside its boundaries are "almost like no man's land, where it is difficult to find out what the regulations are," Harari noted. "Even though many parts outside of the city's boundaries are part of that urban agglomeration, they are in a gray area in terms of regulation." New Delhi, incidentally, is one of the 100 cities selected by the Indian government's smart cities program.

The lack of transparency is another obstacle to smart-city growth that Harari found in her research on India. For one, she said that it was difficult to locate all city regulations

on development in one place. And a general problem she experienced was getting clarity on what the regulations actually meant, which opens the door to more than one interpretation of the law. "The lack of transparency is benefiting someone, and it could be intentional," she said. "When the rules are not clear there is room for negotiating exceptions on a case-by-case basis."

Harari found a markedly different situation in Jakarta, Indonesia, another city that she is currently researching. Jakarta has introduced several data transparency initiatives to reduce corruption, and a lot of information is available online, such as on zoning maps and development project bids. "It is too early to quantify the impact of such transparency, but it definitely seems like a promising approach."

A CHECKLIST FOR SMART CITY LEADERS

- Set metrics for activities, and also for outcomes in how residents experience city services.

- Incorporate performance metrics into job descriptions, performance appraisal and compensation structures.

- Transparently disclose performance metrics to the general public to drive greater adherence.

- Vest city administrations with more decision-making powers over their citizens to gain greater leverage when there are multiple jurisdictions at play.

Orlando: Securing Buy-in for Its Sustainability Program

Orlando's sustainability plan seeks to reduce greenhouse gas emissions by 90% from their 2007 levels.

Orlando, Fla., is a city with its eye on an environmentally friendly future. Not only does it take its civic responsibilities in this arena seriously, the city decided to exceed even the climate-change goals of the 2015 U.N. Paris Agreement. Its sustainability plan seeks to reduce greenhouse gas emissions by 90% from their 2007 levels, not the 1990 levels as proposed by the Paris accords. In the center of this effort is Chris Castro, senior advisor to Orlando Mayor Buddy Dyer, the city's director of sustainability and resilience as well as co-chair of the Smart Cities Initiative.

DEFINING THE SUSTAINABILITY CHALLENGE

Orlando found that boosting energy efficiency in buildings was the most cost-effective way to reduce climate pollution.

When it looked at the city's greenhouse gas footprint, it discovered that 72% of these emissions came from the 'built environment' — buildings using electricity that came primarily from fossil fuels. The challenge was two-fold: how to reduce energy demand and help buildings in the city transition to cleaner, renewable and sustainable fuels.

A small but important data point helped guide the city's sustainability plan: About half of the "conditioned space" in Orlando were in 826 buildings that are 50,000 square feet or larger, excluding city-owned buildings. However, they accounted for only 4.2% of the total number of buildings. "So less than 5% of the buildings are consuming 50% of the resource demand for electricity," said Castro. He noted that here, the so-called Pareto Principle, in which 80% of the consequences come from 20% of the causes, is "to see what policies will drive investments in energy efficiency in the largest buildings within our city."

City administrators found that up to 30% of energy waste came from inefficiencies and outdated technologies. That led Mayor Dyer and the city council to pass the Building Energy and Water Efficiency Strategy (BEWES) program. Its slogan: "If you can provide information transparency to the real estate marketplace, you can create a cycle

of improvement to drive energy efficiency in buildings." Orlando's BEWES program was a result of its participation in the 10-city City Energy Project set up by the National Resources Defense Council and the nonprofit Institute for Market Transformation. The City Energy Project aims "to create healthier and more prosperous American cities by improving the energy efficiency of large buildings."

Essentially, the city wanted property owners and managers to benchmark their buildings using the Energy Star Portfolio Manager, a free online tool provided by the U.S. Environmental Protection Agency. The energy performance scores collected would then have to be made available publicly. The scoring mechanism is on a scale of 1 to 100. The average national score is 50 and a score of 75 will qualify a building for an Energy Star rating. The scoring mechanism takes into account various building specifications such as the year in which it was built and the building codes prevalent at the time, type of building, number of tenants, square footage and others. The requirement covers both commercial and residential buildings.

In order to monitor the energy and water consumption in Orlando buildings in real time, the city went out to bid and procured an enterprise-wide energy management information system designed by Lucid, a data and analytics software provider. The city will compare its performance with those in 100 other cities that are part of the Connected Cities Research Program that then-President Barack Obama launched in September 2015 as part of a broader Smart Cities initiative.

OVERCOMING RESISTANCE

Initially, the city faced "a tremendous pushback" from building owners and managers who did not want to share their data, Castro said. In all, there were about 1,000 property owners and managers. The real estate industry lobbied hard against the proposals, even though property owners were not required to make any investments. "The opposition was philosophical," Castro noted. "If you don't believe in the science, you won't believe in the policy addressing the science." Property owners and managers initially assumed — wrongly — that the city would require them to invest in energy efficiency upgrades.

The city had to work long and hard to convince property owners and managers that its proposal was in the best interest of everyone involved. Eventually it was able to persuade them to cooperate. It took two and a half years of persistent efforts, from April 2014 to December 2016, to get the plan passed through Orlando's city council. That requirement for the private sector to track energy usage took effect in 2018, and starting in 2020, property owners

will be required to conduct energy audits, or retrofit their buildings once every five years. For its part, city-owned buildings began complying with the BEWES requirements in May 2017, where it benchmarked buildings that are 10,000 square feet or larger. There were 58.

Castro held 350 in-person meetings with building owners; 10 stakeholder roundtables representing professional associations, labor unions, community organizations; two citywide summits with some 300 people each providing inputs and feedback into formulating the policy. After that, the city held six policy roundtables with a select group of building owners, managers and stakeholders to help craft the policy options that eventually went to the city council. "I was sometimes doing three or four meetings back-to-back per day," said Castro.

There were intense negotiations over the policy options, and each side had to be flexible. For example, the city initially proposed covering buildings that are 25,000 square feet or larger, while the real estate community wanted only 100,000-square-foot or larger buildings to be included. The two sides settled on a threshold of 50,000 square feet. "The same thing happened with the over 20 different policy options embedded in the BEWES that we all negotiated back and forth," Castro said. It is also critical to protect city finances. During the BEWES negotiations, there were some service providers who were pushing this forward and wanted to be part of any solution, but it had to be made clear to them that any procurement decisions would have to go through the regular channels of vetting and selection, he said.

THE LANDLORD-TENANT COMPLEX

One challenge cities face is the so-called landlord-tenant complex, especially in multifamily buildings. In most apartment complexes across the U.S., tenants pay the electric bill as it is not included in the monthly rent. In such cases, the building owner has no incentive to invest in upgrading the building's lighting or water heating systems because they do not bear the cost nor get any benefits since their tenants pay the bills. However, such investments do benefit the property owner because the overall value of the apartment or complex will increase, Castro said.

In order to overcome that "split-incentive" situation, Orlando is working with Green Lease Leaders, an initiative that the U.S. Department of Energy and the Institute for Market Transformation set up to encourage landlords and tenants to work together to achieve energy efficiency and sustainability. Useful toolkits are available in the organization's Green Lease Library on how to design "green leases" and make sure investments in energy efficiency do pay off.

A CHECKLIST FOR SMART CITY LEADERS

- Do the analytical research on the cost-effective policies and programs that can drive the greatest reductions in greenhouse gas emissions.

- Engage with the opposition early on to understand their main objections.

- Include the opposition in the policy process; make them part of the solution.

- Be flexible in finding solutions.

Incidentally, Orlando happens to be the theme park capital of the U.S., with numerous hotels and conference venues that account for the bulk of its electricity demand. Notably, the Energy Star Portfolio Manager tool scoring mechanism does not cover the theme park rides because it does not have appropriate benchmarks for those. Consequently, the energy scoring mechanism exempted the theme parks owned by Comcast's Universal Studios and Walt Disney. However, both companies complied with helping track the energy consumption in other buildings that are 50,000 square feet or larger, such as offices, hotels and restaurants.

In addition to Universal and Disney, the city successfully secured buy-in from its utility, the county, the Orlando Chamber of Commerce, academic institutions such as the University of Central Florida and Valencia College, as well as professional associations, hospitals, the airport and aviation authorities, transit authorities, and building owners and managers like Jones Lang LaSalle (JLL) and CBRE Group.

In the end, the energy consumption scores should propel property owners to make upgrades. "Buildings are going to be compared with their competitors down the road," said Castro, adding that after realizing how much money they could have saved, they'd be motivated to invest in upgrades. "That creates a market driver to improve buildings and therefore lower utility costs. Think of it like a miles-per-gallon measure for buildings." In the long run, buildings that invest in energy and water efficiency also will see gains in higher rental and occupancy rates and sales prices. "We need to look at this holistically, from a long term perspective," he said.

GAINS WITHIN SIGHT

Orlando's efforts are already seeing some initial gains, based on an assessment of its BEWES program and PACE (Property-Assessed Clean Energy) financing program. In the City Energy Efficiency Scorecard of the American Council for an Energy-Efficient Economy released in 2017, Orlando ranked 20th among 51 cities with a 10-spot improvement over its rank in the previous year. Boston, New York and Seattle won the first three spots in that order, followed by Portland and Los Angeles, which tied for fourth. About 25 other cities have also adopted the BEWES program, including New York, Washington, D.C., Chicago and Los Angeles.

Orlando is also implementing energy efficiency upgrades in 55 of its buildings at a cost of $17.5 million, with projected savings of up to $2.5 million annually. That project is the result of its participation in the U.S. Department of Energy's Better Buildings Challenge, which encourages property owners, tenants and other stakeholders to help reduce energy consumption. At last count, the Better Buildings Challenge had brought together more than 250 leaders representing 3.5 billion square feet, 650 manufacturing plants, and $5.5 billion in financing investments.

The projected benefits of the BEWES program over 15 years are compelling:

- savings in energy costs totaling an estimated $208 million;
- improved comfort and productivity at home and in the workplace;
- improved air quality and public health, with $64 million in savings with reduced public health costs;
- improved business environment with reduced operating costs, increased worker productivity and higher asset values, plus 500 local high-wage jobs;
- reduced water usage including 900 million gallons of fresh water, as electric power generation is the largest user of water;
- avoidance of 1.1 million metric tons of carbon pollution.

Orlando is already serving as a case example or role model for other cities. It has engaged with consuls general from Canada, Japan, Vietnam, Israel and Dubai. Representatives from several U.S. cities have visited Orlando to learn from its sustainability programs, especially the Green Works Orlando as a framework. In Florida, Melbourne has adopted the Green Works initiative, while Miami is adopting its BEWES model. New Orleans, San Jose and St. Paul are among the other cities that are tapping into Orlando's experience with its BEWES program.

Atlanta: From Fiscal Crisis to Smart City Savvy

Over the past seven years, Atlanta, Ga., suffered a fiscal crisis that has starved its urban infrastructure of badly needed investments. But the city has since bounced back and its stronger financial footing has enabled investments in mass transit and transportation infrastructure, as well as upgrades to municipal facilities. Since then, Atlanta has aimed to create a policy environment that allows for the open airing of ideas, transparency and caution in awarding contracts, as well as active partnerships with academia and business. Notably, Atlanta is the third-largest home of Fortune 500 companies, including Coca-Cola, Home Depot and UPS.

Today, Atlanta's financial woes are behind it and the city is looking ahead. One of its main priorities is smart-city initiatives. Daniel Gordon, the city's chief operating officer, identified the major pillars that drive these priorities:

- Emphasize public safety as the first responsibility, ensuring a sense of order and respect for a safe community.
- Incorporate inclusivity and equity in city programs to ensure that all Atlanta communities benefit.

Atlanta is the third-largest home of Fortune 500 companies, including Coca-Cola, Home Depot and UPS.

- Prioritize transportation, transit and traffic efficiency because they have high impact.
- Focus on economic efficiency, track data to ensure that every tax dollar is spent efficiently.
- Pursue sustainability goals such as improved air quality and energy efficiency.
- Create an entrepreneurial environment where the city has access to data and can stimulate entrepreneurs to find solutions to urban challenges.

> **Atlanta uses a machine-learning algorithm developed in partnership with Georgia Tech that leverages natural language processing to scan through the free-text portion of all of the city police department's case reports. It understands the context in which specific terms are used and points to the probability of correlation among cases.**

FOCUS ON PUBLIC SAFETY

Atlanta is using data analytics in novel ways to enhance public safety, led by its then-CIO Samir Saini. In one case, it uses a machine-learning algorithm developed in partnership with Georgia Tech that leverages natural language processing to scan through the free-text portion of all of the city police department's case reports. The technology understands the context in which specific terms are used and points to the probability of correlation among cases.

For example, when the city was working on perfecting the algorithm, it came across a common factor among 17 different burglary cases that it had already closed. The algorithm's output highlighted that in each of those cases, the burglars stole silver — the term 'silver' was contained in all the reports – signaling that the cases might warrant further scrutiny. In this manner, the technology fundamentally changed the way in which the city's investigation department functions.

In the future, law enforcement supervisors could decide on whether they ought to combine seemingly different investigations or have investigators of those cases collaborate as a team. "All of that will ultimately reduce the cycle time of investigations, hopefully bring the suspects to justice, and potentially avoid future crimes by that group," Saini said. His team worked with police departments of neighboring towns, counties and across the state to further enrich their dataset and find correlations in crimes that cross jurisdictions.

One of Atlanta's most ambitious recent endeavors is its video integration center, which currently has more than 10,000 cameras across the city. (The city owns only a small number of those cameras.) Private sector companies work actively with the city's police foundation to test out new technologies to combat crime. They also link in to the video integration center, which provides officers with situational awareness when they go into a scene after a 911 emergency call. The city's 911 Center collaborates actively with the Atlanta Police Foundation and companies.

SUSTAINABILITY INITIATIVES

In February 2017, the city launched a project to install solar roofing on 24 city buildings as part of its Solar Atlanta Program. The city's goals were to increase its renewable energy capacity, reduce energy costs and greenhouse gas emissions, and serve as a model for other cities and the commercial sector on how to deploy solar. Three months later, the city invited bids to replace its aging network of 7,000 to 9,000 high-pressure sodium streetlights with LED lights to reduce both energy consumption and the costs associated with providing right-of-way lighting services.

Sustainability is also reaching Atlanta's Hartsfield-Jackson airport, considered the world's busiest and serving about 105 million passengers annually, not including guests coming to pick up or drop off people. In March 2016, the airport launched a $6 billion expansion project that includes the replacement of aging facilities and a new concourse. That project incorporates several sustainable features.

Atlanta's sustainability drive also extends to the maintenance of its water and road infrastructure using new technology. For example, cameras inside water pipes routinely monitor conditions and check for leakages. On city roads, rapid ice formation is a hazard when rains wash away the chemicals applied to prevent it, and reapplying those chemicals without loss of time is critical. (The severity of these problems is unique to Georgia and the U.S. Southeast, unlike in the Northeast or the Northwest.) Here, sensors help authorities track road surface temperatures and re-treat the roads without loss of time.

In September 2017, Atlanta piloted a novel signaling technology in a so-called 'Smart City Corridor' near Georgia Tech. That technology allowed traffic lights to communicate with each other in dynamic conditions and synchronize the ideal traffic management patterns.

PARTNERING WITH ACADEMIA AND BUSINESS

In its efforts to find solutions to city issues, the mayor's office actively taps into talent at universities such as Georgia Tech, Emory, George State, Atlanta University Center campuses and SCAD (Savannah College of Art and Design), among others. The aim is to attract millennials

to incubators, where they could use the data to drive efficiencies in city services. For example, one idea that came out of a high school science class was to install cameras outside residential water meters to track usage and thereby promote efficiencies.

Active collaboration among city and state agencies, as well as employers, makes much of it possible. The Metro Atlanta Chamber is active, and so is the Atlanta Committee for Progress, a partnership among the city's businesses, civic and academic leaders that meets periodically with the mayor's office to work on issues facing the city.

PROCUREMENT AND ACCOUNTABILITY

Atlanta goes about its city projects cautiously. It routinely uses devices to scour a project's scope by calling for an RFI (request for information) or an RFQ (request for quotation). For contracts above a certain value, the city's procurement department may call for RFPs (request for proposals) through its procurement department, which could take several months. A separate group of experts score the submissions based on specific metrics. Next, the city council typically evaluates the bids, after which they go to a committee, and then on to a city council meeting. Only after that exercise would city officials decide on a contract and negotiate the terms before the mayor signs the purchase order. As an added measure, the city often implements pilot projects before embarking on large projects.

In tracking smart city initiatives, the teams in charge of specific projects meet regularly at the department level and monthly at the mayor's office. They report on the progress in front of the entire group. This results in a high level of inter-departmental understanding of the status of projects. The city administration tracks project implementation using predefined metrics. This gives extra time and other necessary support to city officials that fail to match expectations.

CHALLENGES AND SOLUTIONS

Cities could easily fall prey to a risk-averse culture, where people get comfortable with the status quo. However, in Atlanta, the city administration actively encourages its officials and other stakeholders to suggest innovative ideas to solve city problems, especially those that need government support. Similarly, if projects are stuck for whatever reason, such as those that may need two or more city departments to collaborate, people are encouraged to call for help.

When companies gather data on the city or its residents,

A CHECKLIST FOR SMART CITY LEADERS

- Prioritize public safety and transportation as high impact projects.

- Foster active collaboration among city and state agencies, and employers.

- Recognize that cities, acting as the first mover, can be the catalyst to drive further investments in sustainability projects.

- Be open and transparent in sharing the city's goals because it could convince opposing groups to support projects.

they may resist sharing that with the city administration. In such cases, transparency and openness helps. In one such instance, some mall operators did not want to share their video feeds with the city. The city invited them to a meeting with the mayor and the police chiefs and explained why they needed that data. Once the mall operators saw good reason for sharing those feeds, more mall owners agreed.

Other situations call for creative solutions. One case relates to the city's plans as part of the 100 Resilient Cities program. A group wanted to install solar panels on top of city buildings. Another group wanted investments in LED lamps for street lights, which are not only energy efficient but incorporate sensors and cameras.

Gordon evaluated the two projects using a for-profit approach and found the payback period for the investment in the solar installations to be much longer than that for LED lighting. He suggested a solution in which the city would bring in a private sector partner to invest in the solar panel project. The company would collect revenues over the length of the project, but pay the city a discounted portion of those returns within three years. That would allow the city to demonstrate quicker returns from the project than it would have otherwise. More importantly, the ability to weigh the two projects on common parameters eventually enabled it to implement both projects.

Washington, D.C.: A Smart City Can Be Equitable

"Equitability means being focused on citizens and their needs when identifying how to provide the city's services."

—ARCHANA VEMULAPALLI, former chief technology officer, Washington, D.C.

Equitability is one of the four core objectives that Washington, D.C., identified when it set out to become a smart city. The other three were resilience, sustainability and transparency/collaboration. Equitability means being focused on citizens and their needs when identifying how to provide the city's services, said Archana Vemulapalli, Washington, D.C.'s former chief technology officer.

But equitable solutions don't mean identical services for all. "You need to have solutions that are flexible or can adjust to the needs of your population across the city," Vemulapalli said. Mobility is one such example. "If you talk to residents in the neighborhood that is affluent, they may want to get from point A to point B in the fastest way possible," she said. "But if you go to a different neighborhood where they have financial hardships, maybe their goal isn't necessarily to get someplace in the fastest way." Their priority could be easier access to transit rather than speed.

The equity goal for Washington takes off from its broader objective of wanting "to grow a strong middle class and provide pathways for people who are in financial hardships to get to a much more opportune environment where they can succeed," Vemulapalli said. That approach plays out in mobility, job opportunities, public safety or housing. Those broad areas can be fleshed out into agendas for specific services, such as connectivity. "If we can provide connectivity across the city or make options available where people have the ability to connect at low cost or no cost, now your ability to apply for a job online is improved and your ability to take online training improves," she said.

THE CITY FOOTS THE BILL

Unlike many other cities that rely on partnerships with private providers, Washington decided to use its extensive municipal broadband network for not just government purposes, but also to provide free Wi-Fi to its residents. It launched that program in 2008, and currently provides free Wi-Fi to 18% of its population. The goal is to reach 25% by the end of fiscal 2019. The current rollout includes 650 government buildings, all the schools in the city, all the parking lots, city-run swimming pools and recreation centers, and the National Mall.

Vemulapalli explained how and why Washington's Wi-Fi offering is different from that of New York or Kansas City, Mo., which uses third-party vendors. "Essentially, what those other cities are doing is collecting data, even if it is anonymized to some extent, and they get revenue on it. So it has become a revenue stream for them to generate a service for the residents," she said. "We are trying to build efficiencies internally to give the Wi-Fi as a value-add to citizens at no additional cost."

"We don't collect any information. We wanted to give people a truly free service that really doesn't entail them giving up any more of their personal information than they need to," Vemulapalli continued. "We strongly believe that we should collect only as much information that we absolutely need from residents and not what we would like or want."

Vemulapalli saw the strategy as meeting an economic development objective as well. "We are looking at coming up with ways in which we can help promote local businesses in the area at no charge to them," she said, adding that the city is testing some models at present. For example, small businesses could use the free Wi-Fi for advertising to attract more business. "If you are in the neighborhood and you connect to free Wi-Fi, a local business might offer a free cup of coffee or a dollar off your coffee." These strategies will attract more customers. "The idea is, with the money that we have, are we being strategic with our investments to provide value to residents at no additional cost?" she asked.

She maintained that such free public Wi-Fi must be provided at gigabit speeds, because otherwise, "when you have more than 20 people connect, you will see degradation of service," and capping Wi-Fi speeds will hurt the experience for citizens. "You do need fast speeds to begin with and then you assume that in a shared environment as people connect, they at least get some modicum of service." Washington is part of a Smart Gigabit Communities Program run by US Ignite, a nonprofit that aims to help cities develop two-gigabit applications.

> The city found creative ways out of its funding challenges for Wi-Fi. Instead of trying to finance separate budgets for Wi-Fi services, it folds them into bigger projects such as those for modernizing a school building or renovating it.

Vemulapalli acknowledged that the city's enthusiasm to provide free Wi-Fi is not matched by the budgets available for it. Federal funding for such programs are generally allocated for rural areas that typically have limited coverage and are sometimes not attractive enough markets for private providers. Yet, "in the cities too we have areas and pockets that have lack of [broadband] adoption, but we don't have any funding that comes for it." The total funding the city is able to raise from nonprofits and other sources rarely exceed $200,000 annually, which she said is woefully inadequate.

The city found creative ways out of its funding challenges for Wi-Fi. Instead of trying to finance separate budgets for Wi-Fi services, it folds them into bigger projects such as those for modernizing a school building or renovating it. To some extent, such an approach makes it affordable to provide those Wi-Fi services, and the city does not have to make that investment separately.

THE CASE FOR CITY-FUNDED WI-FI

According to Vemulapalli, it is debatable if a city should take on the responsibility of providing free Wi-Fi services or partner with a third-party provider. For a small city with a tighter budget, roping in a third-party vendor might be the best option. However, a city with a sizable budget could probably use some smart planning with its investments to give residents the same benefits without necessarily monetizing their data to provide free Wi-Fi services. "It is very easy to say here is more advertising and we are going to roll out Wi-Fi throughout the city," she said.

Vemulapalli pointed to other unwanted outcomes if a city takes the route of using third-party providers for Wi-Fi services. "If we put these bright shiny kiosks at the corner of every street, they distract people driving by," she said. "Also, if there is a flu epidemic and everyone is touching that screen, those are areas of spreading the flu." She also worried about street furniture: "We don't want to randomly pepper our streets with equipment because if that becomes obsolete who replaces it?"

A CHECKLIST FOR SMART CITY LEADERS

- Smart-city projects can be equitable, with the right goals in place.

- Equitability is important in mobility, job opportunities, public safety and housing.

- Solutions must be flexible to meet the needs of all citizens.

- Remember that the government focuses on equity while the private sector is motivated by profit.

- Find creative solutions to pay for smart projects without monetizing the data of citizens.

Over the years, several private entities have pitched different business models with projections of advertising revenue that the city could earn. But they weren't attractive enough. "I have not yet seen a very compelling case of where in the long-term [the private providers] would make money," said Vemulapalli.

Vemulapalli further explained why trying to render a public service through a private vendor may not work at all times. "The government is not profit-incentivized. The government is service-oriented and equity is very service-oriented goal," she said. In collaborating with private parties, "what you are doing is taking the goal of equity and pushing it onto a private-sector vendor, which is essentially profit-oriented. They are not going to think that way and it is not fair to expect them to think that way."

She made the case for why she believed that the government should not be in the business of monetizing citizens' data. "We're telling our citizens that we will only collect your data if we need to, and we collect data to improve services for you. The moment I start collecting data because I want the money, I would start collecting all kinds of data that I don't need because it may be of use to somebody else. And that takes me away from my core mission. "

The city's data is available at OpenData.DC.gov for free. The city also puts out APIs and datasets. At last count, it had more than 873 data sets available.

San Jose: The Silicon Valley City Gets Even Smarter

In the heart of Silicon Valley, San Jose, Calif., would seem to have every technological advantage compared to other cities. But that's not exactly true, according to Kip Harkness, deputy city manager of San Jose. "It's a little bit like the cobbler's children who don't have shoes," he said. "The local governments here in Silicon Valley … and nonprofits sometimes exist as if they're in a different Valley." Nonetheless, there is an opportunity to advance smart-city programs and innovation, Harkness said, "by cutting the barriers between the sectors and allowing some of that pixie dust of Silicon Valley to sprinkle inside."

San Jose may be at the heart of the tech world's innovation hub, but the truth is that in many ways it has very traditional government processes for a lot of what it does — like still using paper records. But despite the lack of advancements, the city does offer a rare opportunity "to steal from the best and to collaborate with the best to create something new in all of this," said Harkness. "I can't think of any place on the face of the earth at this moment in time where I'd rather be doing it."

Harkness took on his current role in August 2016 after private-sector stints that included a little more than three

> **"There is an opportunity to advance smart-city programs and innovation by cutting the barriers between the sectors and allowing some of that pixie dust of Silicon Valley to sprinkle inside."**
>
> —KIP HARKNESS, deputy city manager, San Jose

years at PayPal as its director of technology engagement. The move to the public sector came with a challenge: solving tough problems that matter. He said it felt like he was "bringing a little bit of the magic of how tech in Silicon Valley approaches these problems, to the public sector."

One of the defining characteristics of a truly smart city — Harkness prefers the term "learning city" — is that it understands the long-term impact of the decisions it makes. "They are best thought of in terms of how they affect my granddaughter's granddaughter," he said. "As we

begin to take that longer-term view and a little bit of that high road, it is pretty exciting in terms of the problems that you can solve and the impact that you can have."

INNOVATION ROADMAP

One approach that Harkness found useful was the development of an "innovation roadmap," a concept he carried from his experience in the tech sector. Picking the right ideas to implement was the first goalpost in that roadmap. "When I came on board, we had maybe 100 different innovation ideas that were either being pushed by a particular part of the mayor's office or what other people were doing or were opportunistically taking advantage of," he said. "In some ways that's great because there's a lot of innovation that was just organic and naturally occurring. But there was no clear sense of what the priority was, what the focus was or why we would do one thing or not do another."

However, Harkness wanted to focus on the right ideas. "We didn't want to just do innovation for innovation's sake or for press release's sake," he said. His team created a Venn diagram where winning proposals had to meet these three overlapping characteristics:

- Does it solve a problem? Is it important to a lot of people? Is it causing them pain or annoyance?
- Is it core to a city's role? Is it something that's central to what the city should be doing? There are a lot of interesting problems out there, only some of which should be solved by local governments.
- Will technology or process improvements help? Is this problem or pain point actually solvable using technology or process improvement, or both?

"If the answer is yes, yes, yes, we put that in the backlog" of things to do, Harkness said.

CROSS-DEPARTMENTAL COLLABORATION

Next, the city convened a Civic Innovation Cabinet composed of directors from different departments. They went through each item in the backlog, refining them and asking some key questions: How much effort is it going to take to do this? How risky is it? How much of an impact will it have and how core is it to what we do?

For the first time, this process engendered cross-departmental conversation on the most important issues and why the city should be pursuing them. The cabinet scored the likely impact for each of the shortlisted proposals. "By the time we got through the backlog, we had for the first time a collective understanding of what we thought were the riskiest, required the biggest effort, and would have the biggest payoff," said Harkness. The city thus evaluated 70 items that made it to the backlog, and further refined the list to focus on 22 key items. It then roadmapped a plan, built a discipline of execution around those — based essentially on the principles that are used in the technology world — set up an operating rhythm including demo sessions, and began to drive execution of that roadmap.

"By doing that, we supported innovation — not in a broad, generic way, but in a very specific way where we were attacking difficult pain points in the organization," said Harkness. For example, one idea it championed was to produce an app that allowed citizens to report the top five most pressing issues in city government and attempt to resolve them. Those included even simple problems such as graffiti, broken streetlights, abandoned vehicles or potholes.

"For each of them, we focus our innovation and our product efforts on creating beautiful customer experiences," Harness said. "Rather than just going halfway there, we knew that this was a priority and we went all the way there, tip to tail, including integrating with legacy systems and revising our business processes to improve the experience. If this had just been one of 100 items or 1,000 items, it would never have gotten done."

As part of its innovation roadmap, the city also reports back to the person who made the original complaint. "That has been one of our biggest areas of learning because not too surprisingly, a bureaucratic definition of 'done' isn't always the same as the customer definition of 'done,'" said Harkness. Take illegal dumping. "From a code inspection point of view, if I cite the property owner for the illegal dumping, I'm 'done.' But if it's in my neighborhood and there's still a pile of debris on somebody's front yard I don't care whether they've been cited or not — it's not done until it's gone." That learning process turned out to be a healthy education for city officials on changing the bureaucratic

terminology "to fit with what the customer sees and experiences from their driveway," he added.

FINDING INNOVATION FUNDING

San Jose has had financial stresses before, and building public-private partnerships had been one way to overcome budget squeezes. Harkness identified several aspects of financing to gain clarity on options for the city. The first was to focus only on problems that were painful to the organization and core to a city's functions, zeroing in on services for which citizens were already paying money. That allowed it to redirect some of the spending that was occurring with the old systems toward improved processes, techniques and innovations.

Second, it adopted a "catalytic approach" where it paid attention to the value-add that would be generated. For example, if someone rammed their car into a $6,000 park bench, the city would bill the driver. "It turns out we have been doing a really crappy job of keeping track of who owed us for what. We had each different department ... doing that process on their own, and how we followed up was inconsistent and inadequate," Harkness said. "The end result was you probably would never even get a bill for the $6,000."

Chris Mills, the city's head of IT and innovation lead, sat down with the different teams involved and created a centralized approach. He automated the process of collating the requisite information and reaching out to the people involved. San Jose eventually collected $1.5 million more last year than in the previous year, and by using a smaller team to focus on the problem.

"This is an odd example but we have millions of dollars of property that gets damaged by other people every year," said Harkness. "We know who they are but we didn't follow up with them on paying the bill. All we did was start following up more effectively [with the offenders]. They may not be happy about it but they end up paying the bill." That is an example of how the city could self-fund its ongoing innovation work, he noted.

Harkness brought similar processes to other areas, such as animal licensing, code inspections and enforcement. "There are all these small opportunities for more data-informed, customer-driven ways of changing the way we work, and have much better outcomes such as more money coming to the city," he said. "With that catalytic approach, for a relatively small investment from our team, we've built a capacity that actually creates more funds in the long run. We're creating a mechanism that can fund innovation and return money to the city's general fund. Now, you go from being a cost center to being a profit center and there's not

> "I've given us a little bit of a cheat and said that as we are building our innovation muscle, as we are building our ability to champion the customer, learn from data and iterate to improve for our first couple of years, I want to focus primarily on those kinds of investments and projects that have a relatively quick win and a relatively clear return on investment,"
>
> —KIP HARKNESS, deputy city manager, San Jose

anybody on the face of the earth who doesn't want to have a profit center."

Public projects often have difficult-to-quantify goals and long payback periods. But Harkness decided to go after low-hanging fruit that offers faster returns. "What we've done in our first iteration is be a bit selfish with our roadmap and not necessarily tackle some of the wicked problems like climate change or homelessness or transportation," he said. "It is true that a lot of what cities do is to wrestle with what I call these wicked problems that don't necessarily have a clear solution, that are often very long term in nature, that are intractable and require novel ways of doing things because business as usual simply isn't working."

"So, to a certain extent, I've given us a little bit of a cheat and said that as we are building our innovation muscle, as we are building our ability to champion the customer, learn from data and iterate to improve for our first couple of years, I want to focus primarily on those kinds of investments and projects that have a relatively quick win and a relatively clear return on investment," Harkness added.

PARTNERING WITH SILICON VALLEY

Partnering with the best tech minds in Silicon Valley to solve city problems would be an obvious approach for Harkness and his team. In one project, the city is partnering with Facebook to test new technologies around connectivity. Facebook is piloting its experimental 'Terragraph' technology, which has the potential to provide one of the fastest municipal Wi-Fi services worldwide. Facebook has set up a few hundred poles around the city's downtown, and has started testing.

A CHECKLIST FOR SMART CITY LEADERS

- Create a framework to winnow down projects from hundreds of proposals. Focus on residents' top pain points, or those that are core to city services.

- Partner with technology companies to try and incorporate well-proven processes for solving specific problems.

- Identify opportunities to make existing public spending or fee-collection processes more efficient, which will free up financing for innovative projects.

The Facebook project is also helping the city learn new ways of installing telecommunications equipment on street poles, such as for the adoption of 5G technology and build-out of 4G LTE networks even before telecom companies install their own small cell networks. Through the Facebook project, the city would also get to hone its internal business processes and refine its approaches to permitting, Harkness said. Facebook is implementing the pilot at no cost to the city.

Another example of partnering with Silicon Valley is its association with an Intel program called 'Encore Fellows,' where those retiring early from the company can spend their last year working with a nonprofit or public organization. San Jose has brought on several fellows to work on its projects. One of them is Sing-Man Yuen, an Intel executive who is helping the city's teams use 'Agile' methodology, which lets developers adapt software faster to new tech developments, and in particular a development path called 'Scrum.'

"There are a number of teams within the city that can use Scrum methodology to dramatically improve their performance output," said Harkness. "By having Sing-Man Yuen with decades of experience in Intel in using these Agile methodologies come and teach that practice to us, we've literally been able to take that fire from Silicon Valley and light it for ourselves here."
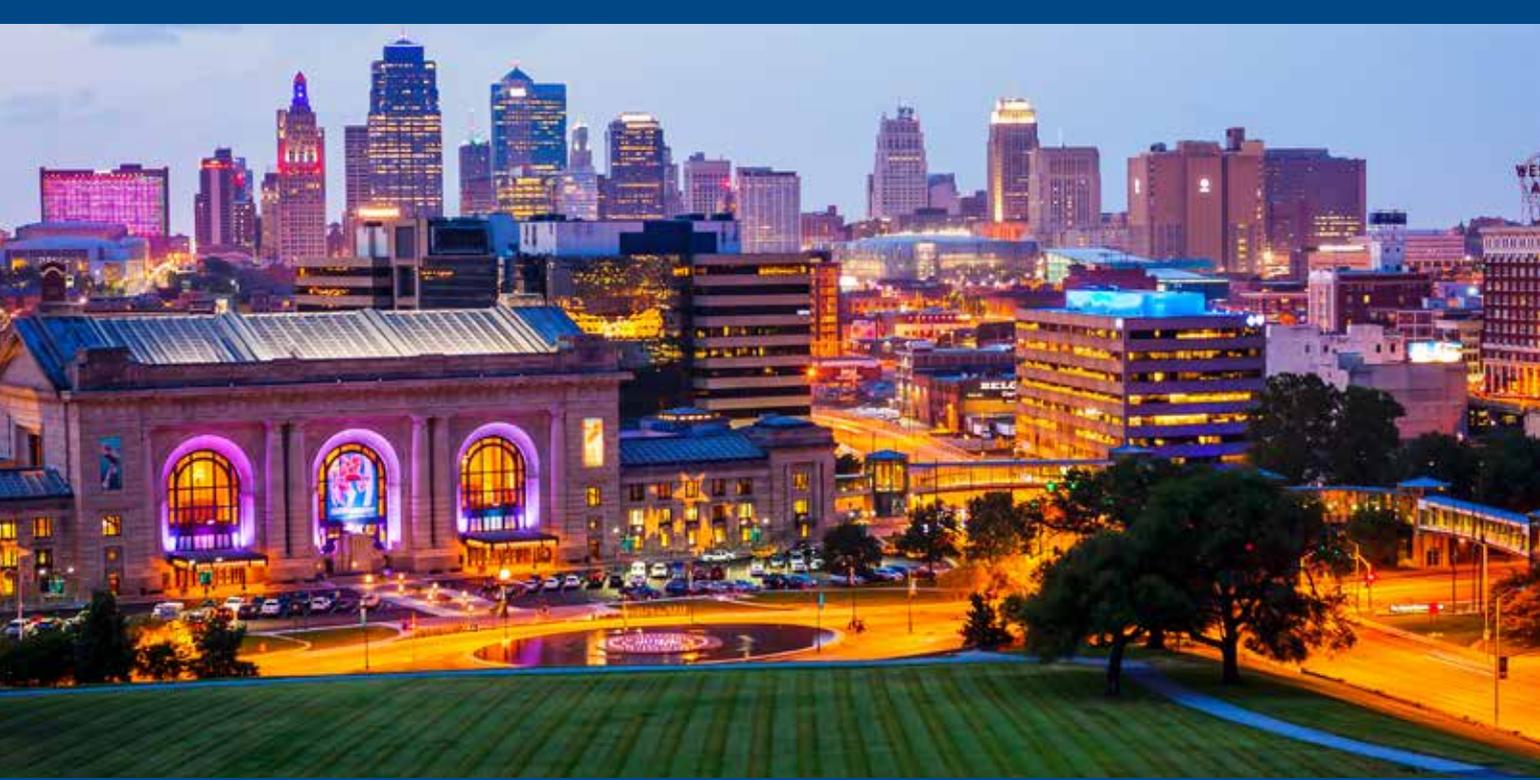
Kansas City: Making a City Data-smart

Kansas City, Mo., has been a pioneer in using a public-private partnership model to provide free Wi-Fi services to residents (through Sprint), and also for Google Fiber to roll out 1-Gbps broadband speeds. Those amenities were made possible by giving service providers controlled access to users' data. But cities also must take care to protect the privacy of residents. With the proliferation of apps from which to access city services, citizens expose themselves to risks as they reveal important personal information, such as financial data.

Bob Bennett, the city's chief innovation officer, said the cornerstones of data protection regimes are the following: giving citizens the choice to decide what data to share and what to keep private, providing transparent governance mechanisms, and ensuring robust security infrastructure and processes. "We have a 'data use policy' for the city, which was introduced in October 2015 and predated any of our smart cities' technology deployments," he said. "We did not install our first sensor until May 2016. So we had a data plan before we collected data. We articulated a 'data bill of rights' for our citizens in that policy."

Cornerstones of data protection regimes are the following: giving citizens the choice to decide what data to share and what to keep private, providing transparent governance mechanisms and ensuring robust security infrastructure and processes.

Bennett said the three main elements of the data use policy are as follows: telling people what the city will do in terms of data collection, anonymizing and aggregating people's data at the block level, not individually, and sharing what it has collected with residents. "We make our data publicly available to concept developers or researchers at KCLivingLabs.org. Folks can get in there and start playing

> **"In Kansas City, we make public the results of our data analysis so that everyone knows what we're looking at, and everyone knows how we're using it,"**
>
> —BOB BENNETT, chief innovation officer, Kansas City

with the data and start developing those tools that will, over the course of the next several years, help us improve public services."

"In Kansas City, we make public the results of our data analysis so that everyone knows what we're looking at, and everyone knows how we're using it," Bennett said. "The advantage that we have over the likes of Facebook [with its privacy issues] and such is that we are required to be transparent and therefore the level of detail that you know that Facebook has on different individuals is so much more granular than what we as a city use. We start with the question 'What is the public good?' and we only collect the data that allows us to achieve that public good."

Data equity and inclusion are very important since not all Kansas City residents have resources such as computers, nor can everyone afford high-speed broadband. "We already have 97% of our community with access to broadband. However, there is a 27% gap, where people who have access to broadband don't take advantage of it," Bennett said. "That is the group we are focusing on, and working with educators, schools and other entities to improve computer literacy."

Bennett continued: "It's about training and making the internet financially accessible to folks where the physical connectivity may be available but it's too expensive. It's building out Wi-Fi so that in some cases it's free to connect, and it's breaking down that last barrier, which is generally the actual technical barrier for 97% of Kansas City — and we've already solved that."

Bennett said Google began rolling out its 1-Gbps fiber optic network six years ago, and has been working on a digital equity and inclusion program. "We have also heavily prioritized in our RFPs (request for proposals) the digitalization of Prospect Avenue in our city, which runs through the heart of our underprivileged communities," he said. "So we are absolutely putting our money where our mouth is in terms of focusing on those needy neighborhoods getting our help most and first, before we

build out the rest of the infrastructure." He added that the city also includes provisions in its RFP for installing gunshot detection systems along Prospect Avenue and also providing public Wi-Fi in much the same model as what it has on Main Street. "That will provide connectivity for no cost in the outdoor spaces for about 60,000 people."

Bennett said the city uses public-private partnerships (P3) to great effect. "Whenever one of our P3 partners — called Unite Private Networks — lays fiber, instead of charging them a traditional permitting fee, they give us 10% of the fiber strands. So if they are laying 288 strands, then we get 29 strands of fiber," he said. "By virtue of that, we have a solid fiber network that the city owns and can use as either a bargaining chip with other companies that want to come in, or we could just use it to make sure that our streetlights are connected or to make sure that other things are more capable by virtue of that fiber."

Kansas City also generates funding for data analysis from the ad sales done on the city's behalf by Smart City Media in its kiosks. "We've so far generated about a little under $200,000 of income for that," Bennett said. "Sprint laid out our downtown network. We have put out a P3 RFP to extend that methodology to the entire city. We're essentially going to allow a company to come in and invest in the city, and over time recoup that investment back through data management or data monetization. We get all that done through public private partnerships, without the city spending a single dollar. Obviously, there is no such thing as a free lunch so I'm sure that there will be costs somewhere, but I think the benefits will certainly outweigh that."

DIGITAL RUST BELT

Bennett said he sees a world where the term 'smart cities' doesn't exist, because those cities that address the challenge of using data effectively and employing sensors to make them more sentient are the towns that will be successful. "Those that don't will become part of a Digital Rust Belt and will not be significant communities on the world stage," he said. "The presumption will be that the community uses data, collects data, and is proactive in its provision of services."

"The same tools that a person uses for getting a ride from point A to Point B to manage their transportation, managing their water bills or manage their electricity consumption bills will be using the same device or the same technology that they use for ordering groceries from an Amazon Fresh," Bennett continued. "Cities are going to be proactive. Instead of waiting for a pothole to be filled, they are going to be doing proactive street maintenance.

Instead of waiting for trash to overflow, the sensors on a trashcan can pick up and replace those trash containers before they overflow. It's happening at an episodic level in some cities but it's not happening systemically across departments. What we're looking for is not the use of data to achieve a specific thing, but using data to achieve activities while sharing that data with other city departments. No city is adequately there yet. My goal is for Kansas City to be the first to get to that point."

Bennett also sees data-enabled cities being proactive, providing services before a citizen needs it. "We have a walkable city. We use technology that tells us where folks live and where they need to get to, so we can decrease traffic and improve public safety." Once data are shared across departments, there starts to be a ripple effect where "the individual's life is now more in tune with the city's life," he said. "Together, they work toward making the community truly accessible to everyone, truly safe for everyone and truly a place where all can succeed. My dream and my vision is for Kansas City to be the smartest city on planet Earth within five years."

But Bennett also pointed out that a smart city is more than just about the data, hardware or software. "Everything that we've done for our smart city strategy has always been about people problems. And it has always been about how we more efficiently manage the same services that quite frankly every city has been working on providing since the days of ancient Rome," he said. "It's all about being able to provide water, being able to provide security, being able to provide a business-friendly environment, being able to coordinate with external entities."

A CHECKLIST FOR SMART CITY LEADERS

- Be open and transparent about the usage of citizens' data.

- Make the data publicly available to help create smart-city solutions but anonymize and aggregate the data.

- Use public-private partnerships to help pay for smart city initiatives.

- Remember that a smart city's overall goal goes beyond technology. It's to meet the needs of the citizens.

The European Way of Designing Smart Cities

Is it possible for a data-driven city to preserve this delicate mix of rational and irrational that seems to define the European urban experience?

Although European cities are often regarded as advanced in both design and implementation of innovative models, they face specific issues that challenge the very notion of a smart city.

Transportation is an example. Compared to, say, American cities, which have been shaped by and for cars, a typical European street is used by pedestrians, cars, bikes, public transport — a complex network of lanes with different speeds, rhythms, safety needs and user behaviors. That's why making transportation smarter does not prove easy.

Another challenge comes from the specific characteristics of European cities – they have urban identities that mix history, density and the art of life. Urban planning alone never comes close to providing such an experience. This is not to say that these cities were not designed, or that they just grew organically. Most of them were redesigned, actually. Their modern identity was shaped through a tension between vernacular growth and an effort to rationalize the city.

The result is a dynamic balance of the rational and the irrational, and of the organized and the disorganized. Should a smart European city just be more efficiently organized? Or is it possible for a data-driven city to preserve this delicate mix of rational and irrational that seems to define the European urban experience?

These challenges are all the more sensitive as European citizens express high expectations on issues related to smart cities, to which local elected representatives are required to respond.

The collective preferences of Europeans must be considered, as well as the public policies that derive from their choices, but also the most significant items on the political agenda at a city level. The issues of economic development and growth are not absent from political

discussions at local or metropolitan levels. But they are mainly carried to other administrative levels, such as the Länder (or states) in Germany, or to the national level in Italy, France, or the U.K.

A significant part of cities' budgets comes from taxes collected at the national level. The idea of a bankrupt city is almost unimaginable in Europe. As a result, European mayors tend to focus on other issues, which vary according to their constituents' sociology and proclivities: social inclusion, urban planning quality, and protecting the environment. European and national standards often guide these choices.

Europe is without doubt the part of the world where the notion of public services has experienced the greatest historical development, and voters are committed to maintaining and developing this heritage. While delegation to the private sector is common in some areas such as waste or water management, the companies that provide these services integrate — contractually or, more deeply, in their corporate culture — a certain idea of the city as a common good, and not just as a market. This dimension is certainly present in the U.S., especially in small towns.

In Europe, that sentiment strongly influences service providers. A significant proportion of these services is provided directly by municipalities, or through the agencies they control. This is particularly the case for public transport. In France, paradigmatic developments such as the rise of shared vehicles have been driven both by private actors and by a strong commitment from some pioneering municipalities (Lyon, La Rochelle and Paris).

The close interaction between public will and private actors has sometimes led to failures. However, it has also helped to integrate, from the outset, disruptive initiatives into an action framework largely defined by public policies. Finally, the elected representatives could draw electoral arguments from these developments, combining a fidelity to the political heritage of public services and a strategic vision allowing their city to project itself into the future.

The approach of European mayors to smart city initiatives is defined by two factors. One relates to issues specific to cities in the Old World, making it urgent to explore innovative solutions. The second derives from a political obligation — or at least a strong incentive — on the part of municipal administrations to address these issues.

Hence, Europe now has a large body of experience in smart cities, with its share of failures. It has gradually shaped a "European way" of designing and implementing smart city solutions.

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THE EUROPEAN INTELLIGENT CITY

Without going back to the urban engineering of the Roman Empire or to the utopian architects of the 18th century who imagined perfectly geometric cities, the idea of a rational city has long found its way into the European imagination. That is all the more so perhaps because most European cities were founded during the Middle Ages and were just, for a long time, muddy and unsafe places. Their history can even be read as successive attempts to free themselves from the past, to emerge from the old chaos and impose an order upon urban swarming.

Venice may be an Italian jewel, but it was originally a technical solution to the insalubrious conditions of coastal settlements in lagoons. As in Chicago after the 1871 fire, chaos sometimes results in a field of ruins. The reconstruction of Lisbon (Portugal) after the 1759 earthquake, of Le Havre (France) after its complete bombing in 1944, or to a lesser extent of Berlin after the German Reunification (1991), were moments of reinvention that made it possible to forge new paradigms, more functional and more rational than previous ones.

Paris takes its current form from the vast urban rationalization operation undertaken in the 1850s by Baron Haussmann with issues of hygiene and traffic, but also from military management of revolutions, where the destruction of old districts and the breakthrough of vast boulevards were relevant solutions.

The urban planning developed in Torino (Italy) by Ascanio Vitozzi at the end of the 16th century is both the spectacle of modern political power and an attempt to rationally manage rainfall and muddy streets (paving did not become widespread until three centuries later), with kilometers of arcades that freed the city from the grip of nature. These paradigmatic cities offered models duplicated over and over—St. Petersburg (Russia) was designed as a northern Venice, Bucharest (Romania) as a Balkan Paris, and Nice (France) modeled itself on Torino.

> **The intelligent city, in its European version, is not necessarily defined by an increase in technology, but by the intelligence of solutions.**

However, the penultimate moment in this long history of European urban rationalization — functionalism — is now perceived as a failure, and a major one. One might recall the story of Brazilia and the unexpected development of slums in the interstices of the perfect city imagined by Niemeyer.

In Europe, functionalism is associated with the name of Le Corbusier and the Athens Charter of 1933. It was the major paradigm of the large urban planning operations undertaken after 1945 in both Western and Eastern Europe, in a context of rapid urbanization and industrial catching-up, along with the rise of technocratic management. Engineering or reengineering the city was not just a matter of techniques and rationalization, but a promise of happiness.

The fall was harder. The areas, districts and cities founded or developed from the 1950s to the 1980s have aged badly, and their failure was a blow to the very idea of a technological and rational vision of the city. While zoning in the U.S. is associated with a suburban life that might be challenged but still appears perfectly acceptable to those who live it, zoning in Europe was associated with large buildings populated with poor tenants, severely degraded and quickly abandoned by those who could escape it. Where in the U.S. urban planning has left problems elsewhere (e.g. in urban ghettos located in city centers), in Europe it is seen as having created or concentrated these problems.

At about the same time the problems arising from these unsuitable urban solutions became obvious, in the 1980s, the validity of older models was being rediscovered, particularly the performance of vernacular urban planning. A good example is Palermo, Italy, which nowadays is a mix of three juxtaposed cities: the historic city, the 19th century districts and the post-war city developed during the Italian economic boom of the 1960s. The management of the intense Sicilian summer heat is optimal in the oldest districts, far less efficient in the wider streets of the 19th century city and it is a disaster in the most recent areas.

The reconstruction of Berlin after 1991 favored, under the architectural audacities, the urban solutions of the 19th century (contiguity of buildings, limited height) over that of the 20th century. In the Berlin case, it was not only the winter conditions that had to be controlled: The challenge was also to reconstitute an experience of the street as a common and civilized space, framed by shops and by the contiguity of the walls, as opposed to the empty spaces of large complexes, open to crime.

We see here a notable notion emerging. The intelligent city, in its European version, is not necessarily defined by an increase in technology, but by the intelligence of solutions. Palermo's ancient urban planning is an intelligent response to the climate challenge, and the 19th century city is safer than that of the 20th century.

To be sure, going back to the good old days is not on the agenda. Medieval urban planning is impermeable to modern transportation and the 19th century city is a big pot of traffic jams. Moreover, Europe keeps an intact belief in the possibility of improving and reinventing the city. Paris appears in this respect as an archetype: It is both a piece of history, the standard ideal of a 19th century city whose structure nobody would dare to touch, and a city that in the last 20 years has radically changed in its relationship to vegetation (greening walls, roofs, pavements; environment-friendly gardening), to car traffic, and to the idea of public transport with pioneering experiences in the field of shared mobility.

However, Baron Haussmann's 19th century project to rationalize the city remains a path whose dependence is obvious in the way innovations are managed (centralized), in the importance given to physical structures (bike-sharing stations and electric vehicle fleets), in the extended role taken by the city council in decision-making and project management. Engineering culture and political culture go in the same direction, which could be defined as technocratic.

This allows the early emergence of innovative solutions like bike-sharing, now expanding worldwide. But it also leads to costly choices, sometimes abandoned. The Autolib car sharing system, although widely used and long considered a success, was abandoned this year with a significant debt for which the Paris municipality and the private operator mutually reject responsibility. Operating costs were underestimated, to say the least. Hence the question: just as Waze is probably doing better to optimize car traffic management than any mayor's decision, aren't agile, light solutions such as free-floating bike-sharing systems more efficient and less costly than the heavy systems designed within technocratic frameworks? Should Haussmann give way to Google and its like?

Seen from California, the answer to these questions may seem obvious. Not in Europe, and not only because of

cultural habits, administrative powers, or because mayors would not want to relinquish their powers. One of the reasons for this reluctance is the complexity of European cities and the difficulties it still poses for one-size-fits-all technology solutions. The interpenetration of problems often leads to a solution that creates new problems, and the 'smart' solutions available today are often monothematic. European cities are the very example of places where a decision on one theme has side-effects on other themes.

URBAN SOLUTIONS, BLIND SPOTS

Going back to the issue of transportation, given the lack of available space, even a clever decision on one transport mode may have unexpected consequences on others. Take Barbusse Street in Paris. In 2000, 90 cars could park on the street, and it took 20 seconds to find a parking place. In 2018, 50% of the parking space is now dedicated to public bikes, electric cars, deliveries, and disabled person's vehicles; it takes 15 minutes to park a regular car.

The decision that led to this outcome had a goal of fighting pollution through the implementation of smart systems. But an effective solution should not just be about technology, as exemplified by another Parisian example: the introduction of articulated buses offering 60% extra seats. It was a clever move and a good incentive to use public transit. However, it led to these buses blocking other cars and then themselves in roundabouts, like the proverbial snake biting its own tail. The point is that city councils have learned the hard way that urban solutions, be they technological or not, have lots of blind spots, and that smartness is expected not from the solution itself but from the analysis leading to the choice of a solution.

When smart solutions are out of the scope of public decision-making, they might have unexpected and undesirable effects. Waze, a navigation app that has changed the lives of many drivers, also changed the lives of people living on small streets when cars are routed through their roads. City traffic is undeniably more fluid and better managed this way. But it can also infuriate citizens, destroy some economic value (real estate, local businesses) and unsettle the urban balance of an entire neighborhood. Perhaps in 20 years, people will come up with a better way. But in the meantime, there is a suspicion that a new solution will bring a new problem.

Beyond the question of technological maturity, data-based solutions pose another problem, to which European leaders as well as European citizens are sensitive. It's not just about privacy, as one might expect. It's about the implicit idea of an efficient city, and the people

> **The art of living in the city is also made up of surprises, encounters, detours, and changes of mind. The image of a city that is all about efficiency and does not stop — that is quite the opposite of the European idea of a city.**

who experience it. The technological sophistication of data-based solutions allows them to manage data with very fine granularity, narrowing down to the individual. But human flows, and more broadly the city itself, cannot be understood simply in terms of individual choices, or optimization. The city is a quantum reality; it mobilizes groups as well as individuals, and solutions set up for individual uses cannot manage groups in the same way.

Besides, city residents are not — and don't see themselves as — just rational calculators. Just as a tourist likes to get lost in wonder from time to time in a foreign city, the city experience is not just about efficiency or performance. The art of living in the city is also made up of surprises, encounters, detours, and changes of mind. The image of a city that is all about efficiency and does not stop — that is quite the opposite of the European idea of a city.

Finally, the ideal fluidity of the data-managed world is often based on the mobilization of a workforce and in a European context this adds a dimension to the problem. In Paris, the Velib bike-sharing system is only effective thanks to the employees who remove bicycles from some saturated stations and hand them over to other empty stations. Data can help refine the management of activity, but work experience or regulations impose their iconstraints and the technological solution must adapt to them, at the risk of being sub-optimal.

A city is not just a set of individual "users." While the constraints and rigidities of the collective urban reality can degrade the performance of solutions based on individual consumer data, this collective reality can also offer new resources. In the field of electrical energy, Nice in southern France offers a good example. The city is connected to the French electricity grid only by a single high-voltage line. During a very cold winter, or a very hot summer, this can push the system to the limit.

Two options have been explored in Nice. The first is smart meters, which make it possible to optimize household consumption by using incentives and, later on, with remotely managed power cuts of a few minutes on some

equipment. This "smart" solution has its limits: The impact is small, and citizens are reluctant to let go of their control of electricity consumption.

The second solution is to develop local production. In the world of Tesla and Jeremy Rifkin, decentralized production at the household level would be required. But this makes no sense in a European city where housing is mostly collective and old. It is at the scale of the district or city that solutions must come, with balances to be built between buildings with positive energy, others optimized, and others in which it would not make economic sense to develop electricity production. Intelligence here is not only technical; it is necessarily collective.

THE REPRESENTATION CHALLENGE

This is the dilemma facing European public decision-makers today when they deliberate on the digital solutions that can make the city smarter. Sensitive as they are to the "hidden dimensions" of collective experience, to the multiple constraints that weigh on any change in the delicate balance of the existing city (as messy as it might be), to the unexpected impact that even the best decision can have, they are wary of any "off-the-shelf" solution. Their request is less about customizing systems than about the possibility of integrating them into a systemic approach.

Such an approach has been successfully developed in some eco-districts, notably in Denmark (with the Christiania district in Copenhagen) and Sweden (in Malmö). The issues addressed covered all kind of flows and networks: energy, water, waste as well as flows of people and vehicles. The smart solutions that were developed were detailed through a well-conducted public debate, leading to mutually agreed upon decisions among the inhabitants and various stakeholders. These solutions included high-level technical solutions, in particular about waste, managed mainly by pneumatic pressure in underground networks and not by the usual truck collection. The optimization of energy consumption and CO2 emissions, for example, was not achieved through a single solution (like a smart grid), but by integrating considerations on mobility, residential uses and locally available resources (geothermal and not

only solar) into the discussion. In short, they represented three-dimensional thinking.

In such an approach, which is becoming mainstream in Europe, digital data and systems have their place, but fit within a framework that is defined through the collective discussion of problems among stakeholders, rather than by the range of solutions available.

The issue here is not that citizens want to have the last word. It is to develop reflection and possibly solutions, the value of which will lie in their ability to grasp the complexity of the issues at stake, as well as their entanglements. Collective intelligence then becomes the condition for hoping to rise to the level of this complexity. City councils retain the responsibility to decide, but the intellectual and political construction of problems benefits from integrating, beyond voters, a variety of stakeholders who take the subject seriously, and sometimes at heart.

Europeans strongly rejected the functionalist and technocratic vision of the city, with its top-down decisions and limited intelligence on problems. European mayors have learned their lesson. The way they approach digital solutions to make their cities smarter draws from this lesson. They ensure that they offer their citizens solutions that give them the power to act (to choose a mode of transportation, to know precisely when your bus will arrive or how long it will take you to drive to this spot), or, on less familiar subjects such as energy or waste, and the power to understand. The most favored digital systems in this context are limited to information (on traffic conditions or electricity consumption), or promote the collection of data to inform public debate — a debate in which decision-makers, experts and citizens first and foremost share an awareness of the limits of their intelligence, and of the need to discuss in order to imagine a smarter city.

This European approach of smart cities doesn't give up civil engineering, urban planning, or decision-making. But it articulates them to the notion of civil society, just as it tries to articulate expertise (both legal and technological) with experience. Smartness, in this culture, is a collective activity. It cannot be bought. But a mayor can learn to build it.

Special Report

Smart Cities: A Toolkit for Leaders

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