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Investment in the smart technologies revolutionizing urban mobility, energy, buildings and governance will give birth to a multi-trillion-dollar market in under a decade.

These smart technologies will transform the quality of life for urban citizens and the operational success of businesses.

Cities can become more sustainable, with cleaner air and less congestion. Citizens will not only be able to interact with city agencies easily online or via mobile devices, they'll also be able to get a clear picture of what government is doing and how it's spending their tax dollars. Businesses will be able to file documents, apply for licenses and make use of a wealth of information that lets them plan and succeed.

But, before cities and global businesses can realise these benefits, they need to get right with data. That means not only centralizing and normalizing the data they already own. They must also learn to ingest and analyze data from many more sources while they build data platforms and learn to collaborate among city agencies and with the private sector.

With a proliferation of new use cases, investment and urban-tech startups, the smart-city technology ecosystem needs to embrace a new era of openness and collaboration.

REINVENT CITY MANAGEMENT FIRST

Becoming a smart city can be revolutionary—but it requires a revolution in the way a city operates. In fact, assessing the soft systems of government before starting a project is equally important as performing a data inventory, according to Neil Kleiman, professor of public service at New York University's Robert F. Wagner Graduate School and Center for Urban Science + Progress; and co-author of the book The New City O/S.

Instead of project innovation, he says governments must focus on enterprise innovation: The way government operates and approaches its data must change in order to profit from data.

"It's critical to make sense of what your data culture and your operation culture are--and see what you can do to improve them to get to place of better transparency, coordination and responsiveness to users," he says. "These are typically not the dominant traits of government in America."

First steps

Cities are the opposite of startups. With entrenched staff and processes, bound by regulations and laws, ruled by individuals who likely do not have technical expertise, they are simply not in a position to buy best-of-breed solutions nor to hire consultants to rebuild infrastructure.

This is not such a bad thing: It shields them from getting locked into solutions that don't work and forces them to take an incremental approach. A few small wins by making better use of data they already have can prove the concept to government officials and citizens.

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Kleiman outlines the steps a city should take:

- Take a data inventory or create a data dictionary. This should be a broad assessment of city data that already exists.
- Create a small, manageable team that will take the lead in identifying data priorities and acquiring data from agencies.
- Define what the government's approach will be to data.
- Make a commitment to launch a new approach within a few months.
- Invite all city agencies to get involved and contribute.

While the uniformed agencies—police, fire and EMS—are likely the most advanced in terms of data collection and use, their systems are often proprietary and not interoperable. Still, it's important to include all. In his experience, at the start of these initiatives, if all agencies are invited, perhaps half will jump on board. The team should work with those and, when there's a win, it should be highly publicized. Then, "the other will be shamed into coming on board."

While it can take years to build a robust city data economy, Kleiman has seen cities that have significantly advanced their use of data within a few months.

Low-hanging fruit

Urban mobility gets a lot of attention—and cities and citizens are in dire need of better transportation options, less congestion and less pollution. But Martin Powell, head of urban development within Siemens Global Centre of Competence for Cities, sees improved energy efficiency as an easier win.

For one thing, mobility may require collaboration among multiple city agencies and private-sector companies. Plus, the complexity makes them difficult; for example, there's evidence that transportation networking companies, while providing last-mile alternatives, can increase congestion.

The integration of field components such as sensors, smart streetlights or smart traffic signals can also be challenging, according to Alex Grizhnevich, process automation and IoT consultant for ScienceSoft, a professional software development company.

Parts or all of them may need to be replaced, while ensuring their connectivity with other components and systems takes time and can negatively affect traffic in the short term.

On the other hand, utility companies are already on board. Extreme weather conditions like Super Storm Sandy have highlighted the limitations of today's energy grids. Says Powell, "Smart-grid projects are now outpacing those focused on smart transportation use cases. At the moment, grid operators are embracing the challenge of updating energy grids, being able to handle emergency situations and building grids for the future."

Connecting a utility's data assets with those of a city would allow them to co-create an application that could manage energy usage. It could make

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sure that critical functions, including hospitals, businesses and communications remained up and running during a blackout.

JUMPING THE BARRIERS

Cities face five barriers to becoming smarter—or to using data at all. Because of this, their data engagements, whether internal or with consultants, must be approached and managed differently. The barriers are:

- City hiring regulations and practices
- Funding innovation
- City politics
- Processes focused on procurement rather than monetization
- Citizen concerns about privacy

Innovation vs. the Civil Service

There's certainly a national talent shortage when it comes to data experts, but this is more severe within city governments, which can't simply hire to fill the gap. Kleiman says the lack of staffers experienced with data is one of the most difficult obstacles for almost all city governments. Traditional civil service and HR rules stand in the way.

However, he says, "Those who have made most advances have not shied away from taking those issues on."

One approach is to offer existing employees training. Denver Peak Academy, a city program that trains staff in innovation techniques, offers two voluntary programs for employees. A four-hour Green Belt training focuses on the lean methodology, which entails continual improvement of processes that lead to customer value. At the end of the training, employees receive "green belt" recognition. Black Belt training is a five-day intensive with higher stakes that aims to train employees to become process improvement leaders within their agency or department. After the training, their innovations will be tied to their annual performance reviews.

A hybrid approach—bringing someone new on staff to manage outside contractors—was the tactic used by the City of Columbus after its win of the U.S. Department of Transportation's Smart City grant. The immediate goal is a web-based data platform to serve as the single point of data collection and distribution for smart-city efforts.

"At first we were working with our internal IT team. They have the skills and abilities but it became clear that building [a data platform] is bigger than what our fulltime staff can do. We needed to create a team with the right skills," says Brandi Braun, deputy chief innovation officer, City of Columbus.

Jodie Bare had worked as a consultant and had the experience the city needed. As deputy program manager, technology, she took charge of the RFP process and now manages a team of outside contractors that's building the city's data platform. Bare's hiring was handled through the traditional city process, according to Braun.

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Smart Cities: Embracing the Urban Data Economy

Another tactic is to partner with colleges, universities and training institutes to help existing city staff acquire data skills.

Peak Academy worked with Bloomberg Philanthropies' What Works Cities to teach city employees to access and analyze data. This followed a threeyears-long, failed project with an outside contractor to launch citywide data dashboards.) So far, some 130 city employees have been trained.

"We believe the people who do the work should create the solution," says Jerraud D. Coleman, deputy manager of Peak Academy. "When that happens, the solution sticks. The people who created it believe in the solution and the tool, more so than they would if someone outside told them that was the best tool to use."

Other advantages, Coleman says, are that the city has ownership of the data and that the data literacy of city employees was improved. Now, city staffers are more comfortable using data when strategizing and executing plans. Moreover, taking data in-house allows the city to continue to improve its use of data and increase accountability of staff when they use it.

Finally, while cities can't offer promotions or pay raises to employees who are willing to retrain and lead data initiatives, Kleiman notes that recognition goes a long way.

Peak Academy has a blog it uses to celebrate successes and bright spots. It's shared with current and former green belts and black belts. It also hosts regular celebrations at which people are awarded their black belt lanyards. At these events, an individual within the government gives a keynote highlighting accomplishments, followed by a showcase of innovations inside and outside the city, featuring the employees behind them.

Finally, Peak Academy calls its trainees "innovators." This moniker alone can make employees that they're creative, valuable and part of something bigger.

Funding innovation

You never know where or how you'll innovate—and few cities have a line item in their budget for it. Finding the money for unproven projects can be tough. Brian Elms, Peak Academy's founder, applied for and received \$500,000 a year for two years from the Denver Innovation Fund, with a promise to close the academy if it didn't work.

Careful and continual measurement proved that the academy saw a \$3 return for every dollar spent in the first year, growing to a \$5.30 return per dollar spent in year two. Today, it has eight budgeted positions and an annual operating budget of \$1 million a year from city funds, producing an average annual savings of \$5 million.

The City of Columbus won \$40 million from USDOT and another \$10 million from Paul G. Allen Philanthropies. That allowed it to begin building its data platform, called Smart Columbus Operating System. It's expected to be the central data layer for all future Smart Columbus projects.

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But the city realizes that's only the start: It will need further funding to operationalize its smart city initiative for the long term, according to Braun.

Part of the brief for the Smart City Challenge was to create something that could be used by other cities; moreover, says Braun, to be truly effective, "It's a region-wide thing that has to happen across functions and sectors."

The city is talking to all its partners in the private and public sector, she says, to incorporate smart-city initiatives into long-term plans and budgets.

Some vendors are willing to ease the problem of capex costs with options such as performance management contracting. For example, the City of Orem, Utah, partnered with Siemens to finance upgrades to its streetlighting system; modifications to building automation systems in public buildings; and improvements to building envelopes under an energy savings performance contract.

The infrastructure improvements are expected to create savings of \$11.4 million over 15 years.

Says Powell, "Once you can see the data, you can improve the efficiency of just about any system by upwards of 30 percent. This is what cities are currently leaving on table until they connect their infrastructures."

City politics

And that brings us to politics. If scrounging financial and human resources for smart-city innovation is difficult, it often depends on finding a champion—a mayor, supervisor or councilperson with the clout to make it happen. The problem is, politicians hate to look bad, and there's no guarantee that a data project will succeed, let alone pay off.

In March 2017, Cisco released a report saying that 60 percent of IoT initiatives stall at the proof of concept stage and only 26 percent of companies have had an IoT initiative that they considered a complete success.

Backing a smart-city program requires spending political capital, and not every mayor or councilperson is willing to do that, according to Michael Lake, CEO of Leading Cities, a global nonprofit with the mission of improving the quality of life in cities through smart-city solutions.

"The reality is that very few mayors will be re-elected simply because they have implemented a smart city solution. However, if they try to and it goes horribly wrong, they may not be re-elected," he explains. "Nobody will re-elect the mayor of Boston because we can now pay parking meters with phones. But if there was a glitch, and cars were being towed and ticketed, everyone would remember that."

In addition to the uncertainty of success, Lake notes that the real benefits of smart-city projects may not show up for years—longer than the mayor's term.

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Therefore, the structure of city government and a city's politics play a huge role in which cities try to get smarter. For example, Boston, where Leading Cities is headquartered and which is one of the leaders in smart-city projects, doesn't have mayoral term limits and has had only four mayors since 1968, Lake says. Furthermore, mayoral elections are not so hotly contested in this strongly Democratic city.

In cities where elected officials have less certainty of re-election, as well as those with term limits, officials may be less willing to back projects with uncertain results.

Procurement policies and processes:

Traditional city processes can hinder finding the best solution—or even a good one, according to Lake of Leading Cities. The issues he identifies include:

- Opaque RFPs: "When a tender is released, the assumption is that every potential respondent will be aware of it," Lake says. "But some of the world's best solutions may never know it was released."
- Focus on low cost: Sometimes, regulations may require offering a project to the lowest bidder. In the case of smart-city projects, spending a bit more may lead to a tremendous increase in value. Moreover, there are not as many established brand names for some smart-city applications, which makes it difficult to choose among vendors.
- Resistance of IT staff to software changes: "Cities have some talented people who are fabulous at doing their jobs," Lake says. "But after you become expert in doing something the same way for years, it becomes difficult to see other ways of doing it."
- CIOs are not end decision-makers: Whether that person goes by the title of CIO or something else, he or she is charged with identifying the best solution. But that solution must be "sold" to an agency or executive. For example, Lake says, "They can look at a trash collection optimization package that would reduce the number of trucks needed or reduce amount of fuel used. But ultimately, that CTO has to convince the head of the dept of public works that whatever money was set in the budget is best spent on a software package instead of new trucks. It's always a difficult sell."
- > Privacy concerns: If cities are to truly take advantage of data, their citizens must trust that it won't be misused. Citizens don't always agree on what applications are okay—especially since cities are in the position of trying to become data-centric without a clear roadmap about how data can be or should be used.

For example, the City of Portland, Maine, is converting streetlights to LED in partnership with TEN Connected Solutions, a private company whose fixtures can also provide Wi-Fi, help manage traffic flow, identify open parking locations and many other advanced features.

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But the American Civil Liberties Union of Maine has raised concerns that this technology could be used for citizen surveillance. An ACLU attorney warned smart streetlights could lead to invasion of privacy and infringement on civil liberties, even though the data is collected in public space.

Albert Gidari, consulting director of privacy at the Stanford Center for Internet and Society, warned that cities and the vendors angling to help them get smarter are neglecting privacy altogether. He wrote on the center's blog, "The fact is that there is an astonishing lack of privacy law applicable to most aspects of smart city data collection and use."

Franco Amalfi, director of innovation, Oracle Public Sector North America, says a privacy policy is the number-one thing cities need to think about. "The more data they collect on people, they have to disclose how that data will be used and for what purpose."

He gives the example of the City of Toronto's work with Google's Sidewalk Labs to create an urban demonstration project on its waterfront. "They didn't address privacy upfront, and citizens were concerned. When you're dealing with public/private data, you need to think through the privacy policy and explain how data is collected—and get consent," he says. (Toronto and Sidewalk turned down interview requests.)

Ideally, cities would ask citizens to opt in to data collection, the way private companies do. But there's no way to eliminate individuals from public data collection activities such as traffic monitoring.

"This is an evolving area," Amalfi says, adding that Oracle is in discussions with some cities about developing privacy policies.

Herb Thompson VMware's senior strategist for state, local and education, points out that commercial cloud infrastructure can be secured with automation and software and that, in fact, most data, applications and systems run within city and state governments are already secured via vendors such as VMware.

"When you talk to city and state CIOs, they are worried about security at all levels. They want to make sure they have same security protection inside the data center and in the cloud," he says, adding that when data is moved from city servers to cloud providers such as Amazon Web Services, the same security protocols can be automatically enforced.

What the public sector should not do is fall back on that private-sector tactic of asking for forgiveness instead of permission.

BUILDING THE FUTURE CITY ON DATA

City officials and vendors alike have signed on to the open data approach. An easy exchange of data via APIs and/or data marketplaces, along with the ability to easily add partners to the ecosystem, are critical components of any smart-city platform.

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ScienceSoft's Grizhnevich proposes a three-dimensional architecture concept:

- IoT-based smart city-platform
 Service management solution
- Citizen portal

And he's created a shopping list for a basic smart-city platform:

- The network of smart things for gathering data.
- **Field gateways** for facilitating data gathering and compression.
- **Cloud gateway** for ensuring secure data transmission.
- **Streaming data processor** for aggregating numerous data streams and distributing them to a data lake and control applications.
- **Data lake** for storing data the value of which is yet to be defined.
- **Data warehouse** for storing cleansed and structured data.
- **Data analytics** tools for analyzing and visualizing data collected by sensors.
- **Machine learning** for automating city services based on long-term data analysis and finding ways to improve the performance of control applications.
- Control applications for sending commands to the things' actuators.
 User applications for connecting smart things and citizens.

Says Grizhnevich, "Whatever out-of-the-box smart city platforms exist out there, they are not widely sold and have not proven their reliability in the market." Even when vendors offer all the necessary components, they still need to be customized and integrated, he adds.

Monetization

Eventually, cities might be able to monetize their data by licensing it to third parties and even by using it to deliver targeted advertising, according to Oracle's Amalfi. While there will be resistance from citizens to being charged to use data they already paid for via taxes, he notes that Copenhagen operates the two-year-old City Data Exchange, a marketplace that aims to connect regional buyers and sellers.

"Why shouldn't cities be able to generate revenue like the private sector does? There is a definite possibility of this being successful," he says.

Thompson of VMWare identified an indirect payback from gathering city data: "Every city mayor is focused on economic development," he says. Cities could use sensor data coupled with other data sources such as economic and tax data; parking and transit use; pedestrian traffic; and even market data to attract new businesses to certain locations.

Targeting advertising is a very early-stage concept, Amalfi adds, but he insists lots of cities are contemplating this. For example, a city's data platform could be used to trigger location-based ads when a city-run tourist tram pauses in a downtown location. Or, it could offer this functionality through

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a city-produced app designed for tourists. The city would be paid by the business for generating the lead.

"There's no reason a city can't play the same role as Google," he says.

FINAL ADVICE

Those ideas are in the future. Most cities still need to get started—and they should start small, according to Denver's Coleman. "Chunk out your improvements," he advises. When you look at a smart-city platform, it seems like there are hundreds of things to do.

Instead, he advises setting small and realistic goals. "Maybe have one to three big goals per year," he says, "not ten or twenty."

Leading Cities' Lake has some advice for vendors, too: "Don't just come to me with a solution. Come to me with a problem."

He says that sometimes, startups identify a problem the city didn't know existed. Parking meters is a good example. Coin-operated meters work fine for cities, but they were a huge issue for anyone who didn't have a quarter.

A more leading-edge problem Lake sees is optimizing trash collection. Instead of sending trucks to every location on a regular basis, it should be possible to reduce carbon emissions and reduce congestion by better routing.

Right now, a city might not know how much it might save by optimizing trash collection. That's where data comes in. But a vendor pitching such a solution should do its homework, come up with some answers and use storytelling to make the data come alive, Lake says. "If you can tell the story, you are educating them on their challenges."

Oracle's Amalfi says citizens can be sold the same way. "A smart city is not just about IoT or sensor data," he says. It's about using data to ultimately build better user experiences for citizens. "We should be striving for an Amazon or Apple Store experience. That's what people expect and what cities should be striving for. Cities can create excitement about what they do and make want people to live there, because an exciting place to be."

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- angle Urban enterprises must adopt tech to attain tangible operational & sustainability goals \sim
- > Future cities require infrastructure, and this can't wait. Investors will provide capital today
- Revenues & public service are not mutually exclusive Cities need to create platform attractive to investment & disruptors
- > Technology providers must embrace openness & enable collaboration
- Citizens and customers need to be able to trust in how data is being utilized
- > Smart innovation must driven by outcome, impact & opportunity not devices

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