

ESITHOUGHTLAB

A leader in evidence-based research

Building a Hyperconnected City

A Global Research Initiative

#HyperconnectedCity

START 

Lead sponsors

Deloitte.

EAT•N
Powering Business Worldwide

GENERAL MOTORS

 **JLL**[®]

 Microsoft

ORACLE

 **Pennoni**

 **Stantec**

VISA

Supporting sponsors

Cognizant

Center for
The Future
of Work

 **NTT**

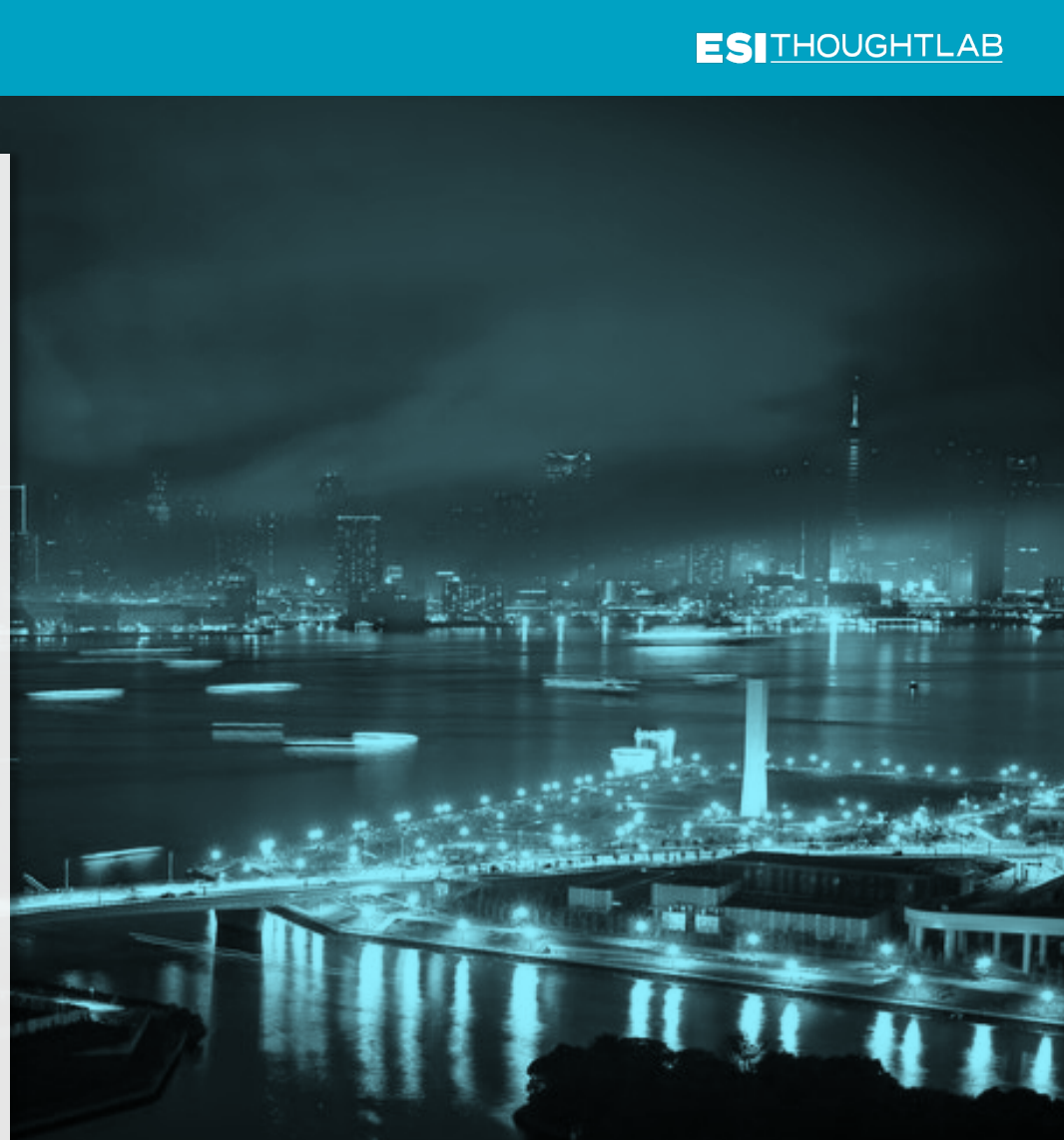
NOKIA

Introduction

This eBook presents the business case, best practices, challenges, and performance metrics around becoming a hyperconnected city—one that drives huge benefits to stakeholders by interlinking its assets through the latest technology.

Created in conjunction with a coalition of corporate sponsors, this interactive eBook allows you to easily access the most pertinent analysis on hyperconnected cities by using the navigation bar at the bottom of each page.

We hope that the report provides you and urban and business leaders around the world with the evidence-based decision support needed to drive urban success.



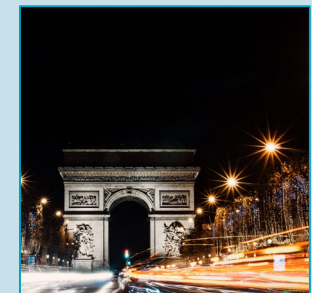
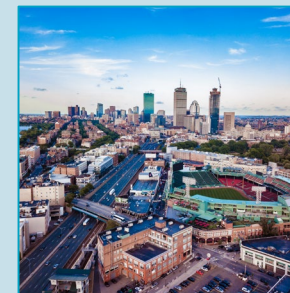
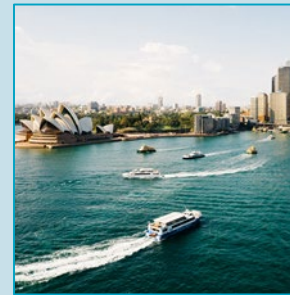
A message from the program directors

Urban residents and businesses are embracing technological innovation faster than many cities can react. With digital change happening in hyper-speed, urban leaders need to act now to bridge the widening technology gap between their cities and stakeholders. Cities adopting smart technologies are already seeing less crime, congestion, and pollution, as well as improvements in public health, productivity, and living conditions.

But becoming a smart city is no longer enough, particularly if public leaders expect to keep citizens on board. To unlock the full economic, social, environmental, and business value from technology, cities need to morph into hyperconnected urban centers: those that use the latest technologies to transform and interconnect key areas of their ecosystem—from roads to cars, buildings to energy grids, citizens to government, and cities to cities. By doing so, urban leaders can fuel a virtuous cycle of economic, business, environmental, and social gains, which in turn will attract additional business, talent, and investment.

To provide urban leaders with guidance, ESI ThoughtLab conducted a comprehensive study into the practices, plans, and performance results of cities already on the hyperconnected path. By categorizing cities according to their level of maturity, we were able to analyze the investments, strategies, and technologies that drive the highest ROI and the hurdles that can get in the way.

As part of our research, we gathered benchmarking data from 100 cities, conducted in-depth interviews with city leaders, and drew on valuable input from a cross-industry coalition of leading firms and research organizations. This eBook provides an evidence-based roadmap that cities can use to become vibrant, hyperconnected urban centers of the future. We hope that cities will find it a valuable tool for planning ahead.



Louis Celi
Chief Executive Officer
ESI ThoughtLab



Daniel Miles, Ph. D.
Chief Economist
ESI ThoughtLab



Sponsors and research partners

Building a Hyperconnected City was sponsored by a cross-industry coalition of companies that specialize in urban innovation and development. Each organization is an expert in its own field and would be happy to share its perspectives on the research results and best practices for your city.

We also were fortunate to have a group of distinguished research partners that provided valuable inputs and guidance throughout the process. Their blend of perspectives ensured an insightful and balanced view of the issues that urban centers face as they strive to interlink their urban ecosystems.

We would like to thank our sponsors and research partners for helping us develop this groundbreaking study.

Lead sponsors



Supporting sponsors



Research partners



Advisory board

ESI ThoughtLab would like to give particular thanks to the individual advisors who contributed their valuable time and knowledge to support our global research initiative, *Building a Hyperconnected City*.

We drew on their expertise to develop our research program, and their advice ensured the acuity and rigor of our analysis.

We would also like to thank the 100 cities that kindly provided data and analysis on their hyperconnected programs. Without their input, this research would not have been possible.

Olga Algayerova
Executive Secretary
UNECE

Franco Amalfi
Director of Innovation
Public Sector North America
Oracle

Philip Bane
CEO
Smart Cities Council

Suparno Banerjee
Global Public Sector Lead, Enterprise
Nokia

William Baver
Vice President
Smart World Team
NTT DATA

Jesse Berst
Chairman
Smart Cities Council

Eugenie L. Birch
Lawrence C. Nussdorf Professor
of Urban Research & Education
Penn IUR

Nicolas Buchoud
Founding Principal
Renaissance Urbaine

Bruce Cundiff
Vice President
Business & Economics Insight Team
Visa

Chungha Cha
Co-founder & Chair
Re-Imagining Cities Foundation

William Eggers
Executive Director
Center for Government Insights
Deloitte

Kari Eik
Secretary General
Organization for International
Economic Relations

Michal Filipowski
Global Innovation Manager
General Motors

Raúl García Rodríguez
Regional Director of Operations
BOGARIS

Kensey Kaminski
Senior Marketing Specialist
Urban Places
Stantec

Mahesh Kelkar
Executive Manager
Center for Government Insights
Deloitte

Jeremy Kelly
Lead Director
Global Research Programs
JLL

Dr. Olga Kordas
Director
Viable Cities

Jordan Kostalec
Director of Proptech
JLL

Christopher Lalonde
GM GCCX Director
Connected Vehicle Business
Operations
General Motors

Arnaud Legrand
Head of Public Sector Marketing
Nokia

Stuart Lerner
Executive Vice President
Infrastructure
Stantec

Ben Levine
Executive Director
MetroLab

Gerald Maduabuchi
Business Development Manager
Uchald

Suzette Malek
Global Research Manager
General Motors

Nancy MacDonald
Vice President, Urban Places
Smart Cities Lead
Stantec

David Noone
Senior Manager
Research & Insights Group
Deloitte

Susan O'Connor
Global Director for Smart Cities
Oracle

Benjamin Pring
Director
Center for the Future of Work
Cognizant

Joan E. Ricart
Co-Academic Director
IESE Cities in Motion

Gulnara Roll
Secretary to the Committee
on Urban Development
Housing and Land Management
UNECE

Jay Sachetti
Sr. Marketing Manager
Eaton

Kamran Saddique
Co-founder
& Co-Executive Director
City Innovate

Masha Seymour
Marketing Director, Global Research
JLL

Joseph Viscuso
Senior Vice President
& Director of Strategic Growth
Pennon

Yi Wang
Head of Global
Development Program
Anbound

Jason Whittet
Former Associate Director,
Solution Development and
Innovation, 100 Resilient Cities
The Rockefeller Foundation

Susan Wilkinson
Director, Business Strategy,
Smart Cities, Microsoft



Project team

Thought leadership is a team sport requiring close collaboration with our advisory board and the right blend of economic, analytical, editorial, and publishing skills. Special thanks to our project team for their outstanding work on *Building a Hyperconnected City*.



Project and Editorial Director
Louis Celi
Chief Executive Officer
ESI ThoughtLab



Client Relationship Director
Barry Rutizer
ESI ThoughtLab



Graphic Designer
Laura Burtner
Econsult Solutions



Economic Director
Dr. Daniel Miles
Chief Economist
ESI ThoughtLab



Research Manager
Steve Wray
Vice President
Econsult Solutions



Marketing Manager
Mike Daly
ESI ThoughtLab



Senior Project Advisor
Dr. Richard Voith
President
Econsult Solutions



Project Editor and Contributor
Janet Lewis
Executive Editor
ESI ThoughtLab



Project Coordinator
Caroline Lindholm
ESI ThoughtLab



Analytics Lead
Rebecca DeJoseph
Senior Economist
ESI ThoughtLab



Project Editor
Anna Szterenfeld
Director of Editorial Operations
ESI ThoughtLab



Senior Analyst
Jung Liu
Econsult Solutions



Research background



Hyperconnected city initiatives help solve social problems. The smartest cities can become more inclusive through service design, infrastructure planning, and mobility solutions, enhancing livability and driving more sustainable development and economic growth for all.

**Piyush Pandey, GPS Managing Director,
Deloitte**



A rigorous analytical approach

To better understand how cities are using data and technology to transform and interconnect each part of their urban ecosystems, ESI ThoughtLab conducted a four-pronged research program:

- 1. Benchmarking survey of 100 cities worldwide.** We surveyed cities about their use of advanced technologies, data, and analytics across all areas of their urban ecosystem, and gathered in-depth data on their smart city investments, outcomes, and returns. All ROI data was self-reported.
- 2. Hyperconnected Cities Index.** Our economists used the survey data to develop a hyperconnected maturity index that ranks cities by their progress in four key areas of excellence—technology, data and analytics, cybersecurity, and citizen engagement. Therefore, the rankings may differ from other smart city outputs, since we are measuring different dimensions of connectivity.
- 3. Secondary city data from trusted sources.** To augment the survey data, our economists also collected data from secondary sources on a range of metrics that measure the performance of city services and the quality of life. These sources included the World Bank, Numbeo, and the IESE, among others. The primary survey and secondary data were integrated into a data tool, called the Hyperconnected City Data Navigator.
- 4. Insights from urban leaders and smart city experts.** To identify best practices, we held in-depth interviews with government decision makers in smart cities around the world. These interviews provided the basis for in-depth case studies (see Conclusions and Case Studies). Throughout the research process, our distinguished advisory board of business and academic experts provided valuable input and insights.



For more on our research methodology, please see the Appendix. For examples, go to Conclusions and Case Studies.



How we conducted our survey

The survey was administered through personal phone interviews with qualified government officials from 100 prescreened cities around the world. Fifty-two percent of the respondents were the senior executives in city departments and 48% were direct reports.

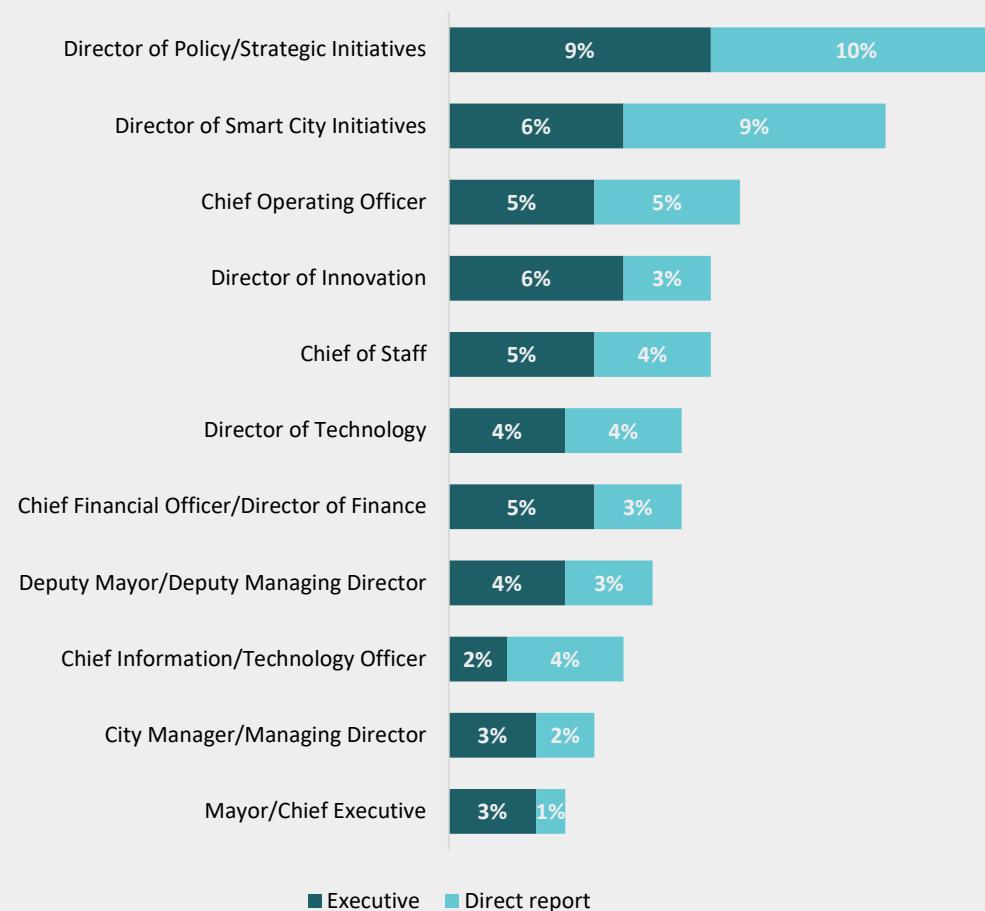
Twenty-five percent of the survey respondents serve in an executive function (mayor, city manager, chief of staff); 40% have a technology role (chief technology officer, chief information officer, director of smart city initiatives, director of innovation, or director of technology); nearly 30% have a policy or operations role (chief operating officer and policy director); and 8% of respondents came from the finance function.

The survey included questions to better understand how cities are using data and technology to transform and interconnect each part of their urban ecosystems. The survey also included questions on the investments and returns on hyperconnected projects.

Since the data were self-reported, we took quality control steps to ensure its accuracy, including comparing survey data with respected third-party analysis, rechecking survey input with cities where there were questions, and reviewing the output with our advisory board.

Since our benchmarking survey required urban leaders to provide best estimates and qualitative inputs, the analysis should be viewed as directional and a work in progress. We encourage benchmarked cities to provide further input as their urban ecosystems evolve and any refinements to ensure the timeliness and accuracy of the data.

Titles of survey respondents

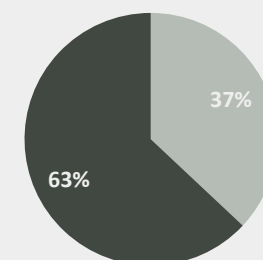


Profile of cities surveyed

We compiled a list of 171 leading smart cities to target for the survey. To be included in our benchmarking study, the city had to be ranked as a smart city on at least one of the following smart city lists – IESE Cities in Motion Index, Top 50 Smart City Governments, Easy Park Smart City Index, Juniper Research Top 20 Smart Cities, and Deloitte’s China Smart City rankings. The 100 cities surveyed ranged in size from 123,000 to over 24m residents and represent nearly 400m city dwellers worldwide. About one-third of the cities surveyed are in emerging-market economies, while the other two-thirds are in developed countries.

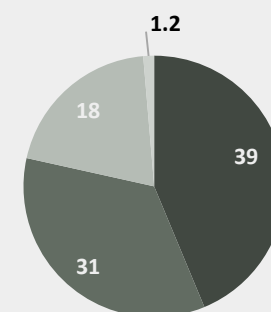


By level of development



■ Advanced ■ Emerging

By population



■ < 1 million
■ 1 million to 5 million
■ 5 million to 10 million
■ > 10 million



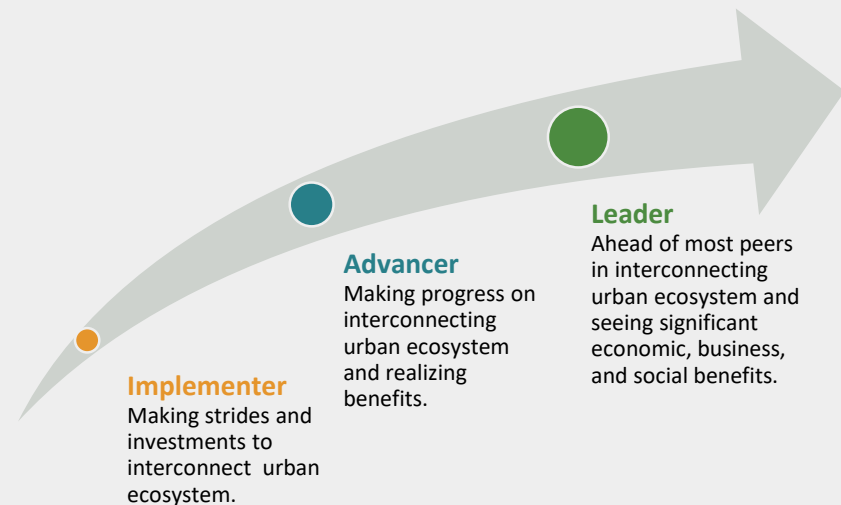
Hyperconnected city index

Hyperconnected cities unlock the greatest economic, business, and social value by leveraging technology to transform and securely interconnect key areas of their urban ecosystems, including citizens. Measuring the use of smart technology is not enough. To create the Hyperconnected Cities Index, we looked at four pillars of city transformation: technology, data and analytics, cybersecurity, and connected citizens. Since our focus was on “connected” cities, the index varies from others that measure a city’s use of smart technologies.



Three stages of building a hyperconnected city

To underpin each of the four pillars, our economists used data from several survey questions, calculating a score for each, and then normalizing and combining them to arrive at a pillar score. We then aggregated the pillar scores into an overall index score. Based on these scores, we stratified the cities into three categories: implementer, advancer, and leader. (Please see the appendix for additional information on how we calculated the Hyperconnected City Index.)



Cities by maturity classification

The 100 cities surveyed ranged in size from 123,000 to over 24m residents and represent nearly 400m city dwellers worldwide. About one-third of the cities surveyed are in emerging economies, while the other two-thirds are in developed countries.

LEADERS		ADVANCERS				IMPLEMENTERS	
Singapore	Washington DC	Tel Aviv	Brussels	Geneva	Miami	Bratislava	Bangalore
Hong Kong	Beijing	Charlotte	Montreal	Oslo	Athens	Tampa	Hyderabad
New York	Detroit	Houston	Los Angeles	Dallas	Kansas City	Warsaw	Monterrey
Seoul	Helsinki	Shanghai	Philadelphia	Chongqing	Columbus	Johannesburg	Amman
London	Paris	Zurich	Atlanta	Calgary	Saint Petersburg	Sofia	Kiev
Melbourne	Rome	Brisbane	Munich	Minneapolis	Reykjavik	Cape Town	Dhaka
Copenhagen	Toronto	New Delhi	Stockholm	Nashville	Prague	Bangkok	Ho Chi Minh
Dublin	Berlin	Istanbul	Tokyo	Dubai	Sao Paulo	Buenos Aires	Lima
Madrid	Barcelona	Moscow	Birmingham, UK	Edmonton	Bilbao	Guangzhou	Jersey City
Cambridge	Milan	Amsterdam	Baltimore	Bucharest	Jakarta	Santiago	Cairo
Sydney	Ottawa	Bristol	Vancouver	Louisville	Tallinn	Muscat	Mexico City
Chicago	Shenzhen	Abu Dhabi	Vienna	Doha		Riyadh	Chengdu
Boston		Austin	Orlando	Denver		Bogota	

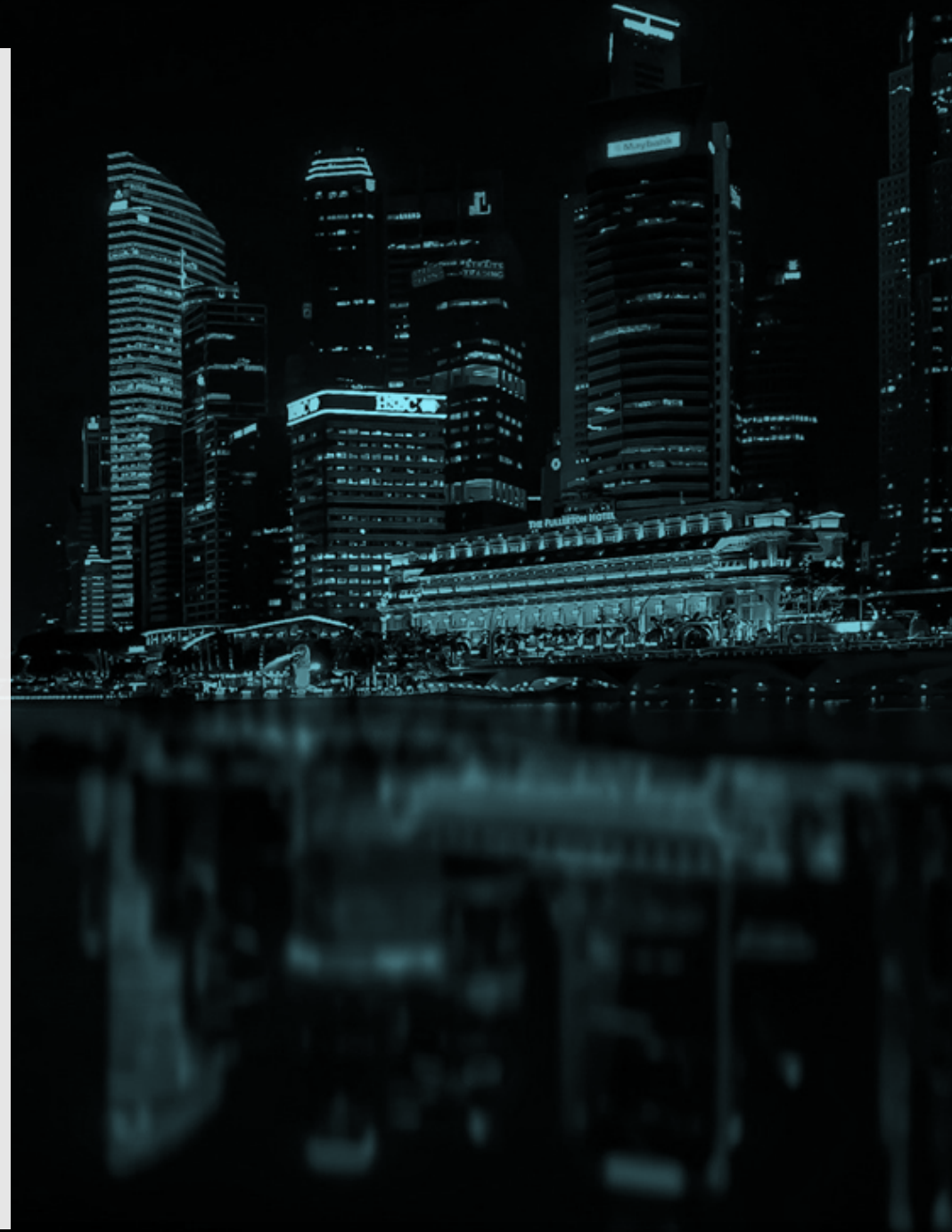


The value of hyperconnected cities



Hyperconnected cities are not just about technology. They go beyond the concept of smart cities by connecting government, business, academia, and citizens. When all four are aligned, cities achieve the greatest economic, business, and social benefits.

**Franco Amalfi, Director of Innovation,
Public Sector North America, Oracle**



Hyperconnected cities drive value by interconnecting key areas of their ecosystems

Hyperconnected cities leverage new digital technologies to transform and securely interconnect critical elements of an urban ecosystem. In doing so, they unlock the greatest potential economic, business, environmental, and social benefits.

To this end, cities are adopting an array of technologies, including public Wi-Fi, the Internet of Things (IoT), cloud, and mobile technology, which are now used by more than 9 out of 10 cities in our study. Other commonly used technologies include biometrics (83% of cities), AI (82%), blockchain (66%), and telematics (52%). By using these technologies in conjunction with wider and richer sets of data, cities are driving high performance across their urban

ecosystems—from smart buildings and roads to smart energy grids and water systems, to smart mobility and transportation—and facilitating real-time interaction among residents, businesses, and government entities and services.

But hyperconnectivity is not just about technology adoption. These cities also excel at building trade linkages with other cities and countries as well as developing partnerships with business and academic communities. For example, 48% of cities we surveyed work with academic institutions to find smart city solutions.

The interconnected urban ecosystem of the future



Hyperconnected cities harness game-changing technologies

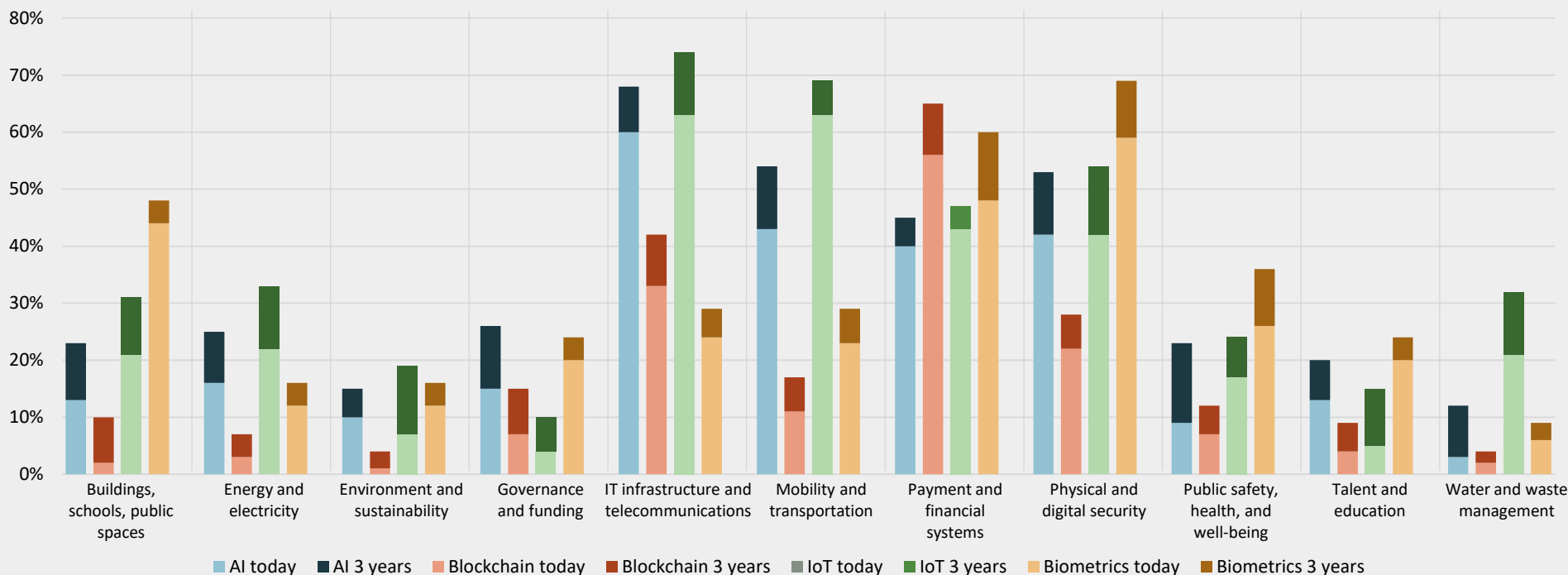
Across their urban ecosystems, hyperconnected cities are widening their use of advanced technologies, such as AI, IoT, and biometrics.

Cities in our sample have already adopted advanced technologies in key urban areas, such as IT infrastructure and telecoms, mobility and transportation, payment and financial systems, and physical and digital security. Over the next three years, use of these technologies will rise not only in those areas, but also in other parts of urban ecosystems. For example, as the price of sensors falls more and cities build the required infrastructure (IT, Wi-Fi, LPWA, 5G, and data management systems), IoT usage will grow by 100% for the environment and

50% for buildings and public spaces, energy and electricity, and water and waste management. Similarly, almost half of the cities surveyed will be using biometrics in buildings, schools, and public spaces, and one-third in connection with public safety and health.

There may be some limits, however. The use of biometrics—particularly facial recognition—has come under scrutiny recently due to concerns about privacy and law enforcement. Civic leaders are also seeing escalating fears about AI because of its impact on jobs and data security, as well as about IoT since it may open the city to cyberattacks.

Percentage of cities using major technologies across different areas of the urban ecosystem



Hyperconnected cities run on data

Hyperconnected cities draw on a wide variety of data to provide value to stakeholders. This includes traditional data gleaned from city departments, local businesses, and citizen surveys to new types of data from IoT, AI, and social media. While crowd-sourced, geospatial, behavioral, and predictive data are now used less frequently, they are slated for a meteoric rise over the next three years. Most cities (57%) now work with businesses and other entities outside of government to gather data.

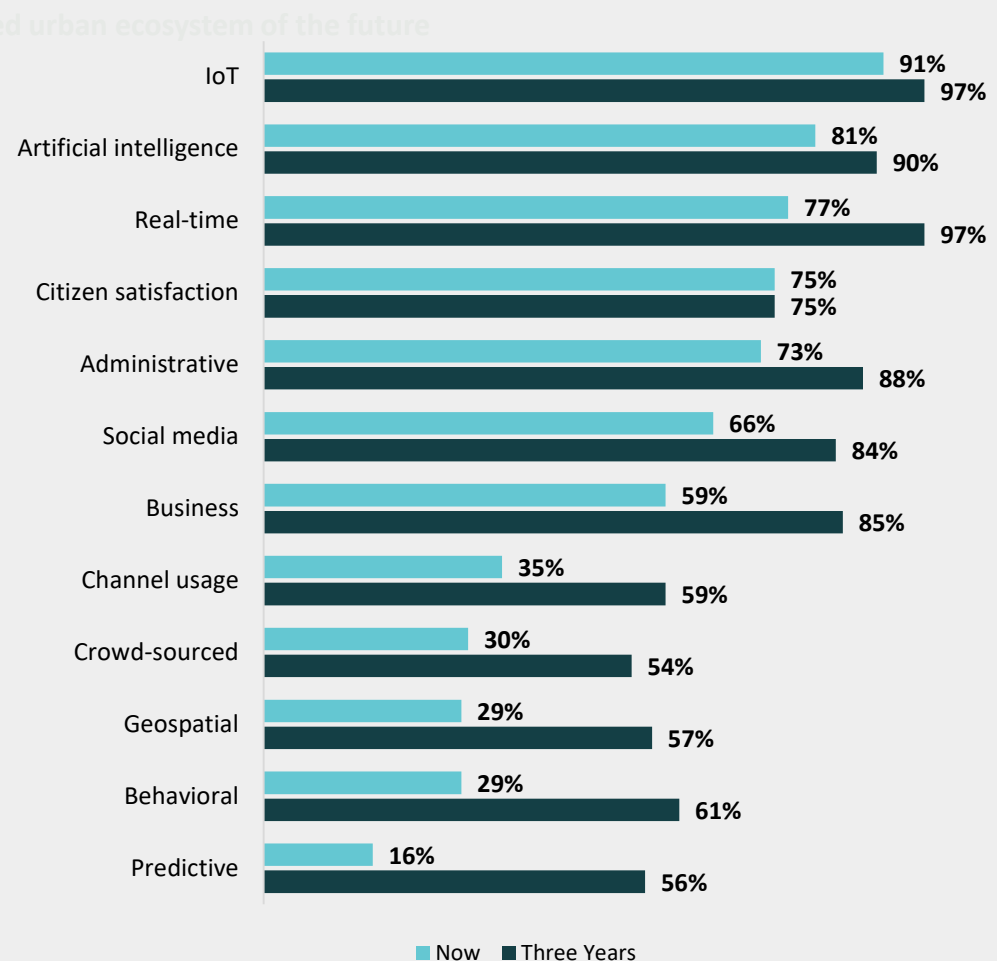
For hyperconnected cities, technology and data work synergistically to drive performance. For example, IoT technology generates massive amounts of data, which 9 out of 10 cities currently harness. Similarly, AI not only enables cities to gain greater insight from existing data; it also generates new data, which 81% of hyperconnected cities now use to provide urban services and solutions.



Data to a smart city is like soil to trees. Smart cities could not grow to towering heights without data. Therefore, the need for open data is rising, but there still is no law in China regarding legal ownership.

Xiaoqi Fang, Economist, Urban Affairs, ANBOUND

Percentage of cities using different types of data today and in three years

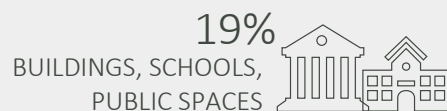
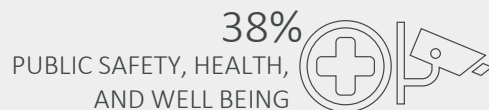
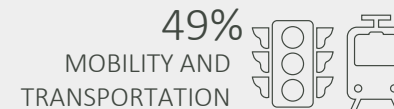
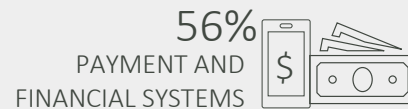
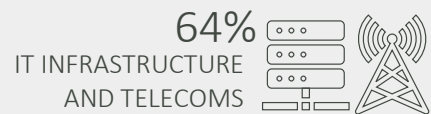


Cities use advanced data and analytics across their ecosystems

Cities currently employ advanced data and analytics to gain insights and improve performance in the same areas that they use advanced technologies: payment and financial systems, mobility and transportation, physical and digital security, and, to a lesser extent, public safety. While a minority of cities now utilize advanced data and analytics in other areas, such as energy, environment, and buildings, usage will rise in the future as these cities expand their adoption of advanced technologies. For example, 44% of cities now have flexible data policies to keep up with changing technologies.

Nevertheless, a few hurdles are still holding cities back. Only 46% believe that they have staff in place with the necessary data analytics, strategic thinking, and problem-solving skills. In addition, 45% of cities feel that their current regulatory environment hinders their ability to use, develop, and manage data.

Percent of cities using data in different areas of the urban ecosystem



Hyperconnected cities boost ROI from many urban areas

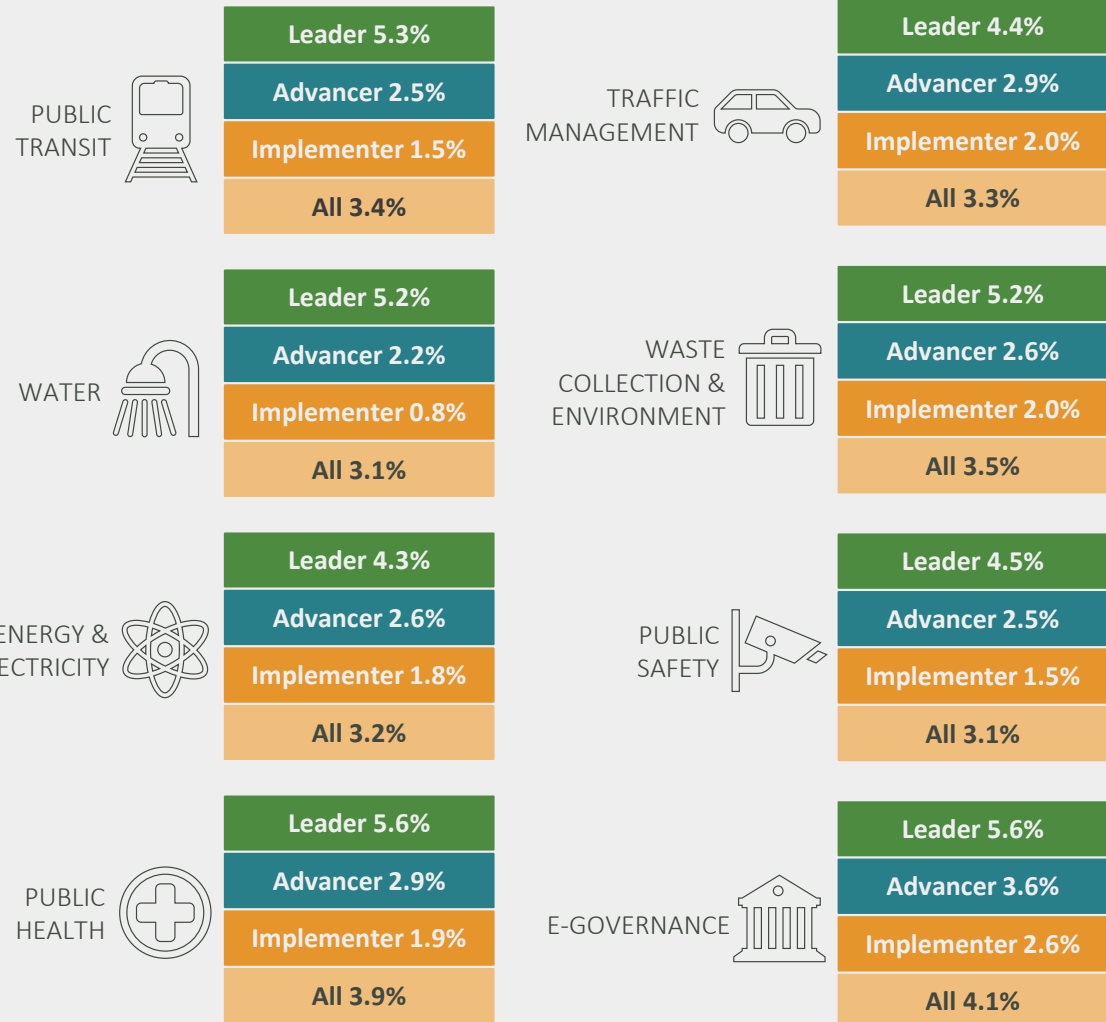
Hyperconnected cities generate tangible returns from their investments through business, economic, financial, societal, and environmental benefits.

According to estimates reported by the cities in our study, the average return on investment across cities for hyperconnected initiatives ranges from 3% to 4%. These results vary depending on the targeted urban area.

Governance projects—such as digital tax filing, digital business licensing, and digital payments—offer cities the highest return on investment across the main areas of an urban ecosystem. These projects tend to offer a more easily measurable direct return in the form of government cost savings or increased revenue.

This likely represents a lower-bound estimate of the potential returns. Thirty-eight percent of cities found that many of the benefits generated by their investments were intangible and difficult to measure. In addition, cities are concerned about more than the ROI. Forty-three percent of cities (52% of leaders) said they would undertake a project that generated no or negative financial returns if it helped achieve a greater societal goal.

As cities become more hyperconnected, their ROI grows. For example, cities just starting to use hyperconnected solutions in governance realize a 2.6% ROI, while leaders see a 5.6% pickup, an increase of 2.1 times. The multiplier effect ranges from 2.1 for governance to 6.6 for water projects.



The multiplier effect in hyperconnected cities

In 2019, our 100 cities report they will spend \$141 billion on hyperconnected projects. This amounts to an average investment of \$1.4 billion per city and \$1,220 per citizen.

The investments range from \$1.1 billion for implementers to nearly \$1.7 billion for leaders. Globally, Technavio estimates that smart cities will be investing \$1.2 trillion. Based on our survey results, overall spending is estimated to increase by 14% over the next year, with implementers seeing the largest increase, at 21%. Cities will be spending the most on mobility and transportation, followed by public safety, health, and well-being.

According to estimates provided by the cities, the average return on investments in hyperconnected initiatives ranges from 3% to 4%. As cities become more interlinked, their ROI grows: those just starting out realize a

return of 1.8% for implementers and 2.6% for advancers, while leaders see a 5% boost.

Based on average ROI, the \$141 billion investment made by the 100 cities in our sample will generate a gain of \$4.5 billion. This amounts to an average of nearly \$45 million for each of our 100 cities—by stage of maturity, the returns range from \$19.6 million for implementers, \$40 million for advancers, and \$83 million for hyperconnected leaders. If the advancer and implementer cities were to become hyperconnected leaders, they could unlock an additional \$2.6 billion combined.

Globally, the \$1.2 trillion investment will yield a return of \$40 billion—and the impact could be as high as \$60 billion if all cities were able to become hyperconnected leaders. This likely represents a lower-bound estimate of the potential returns. Many of the social,

health, environmental and business advantages are difficult to calculate. Such qualitative benefits include creating new business opportunities, filling talent gaps, improving public health, reducing crime, boosting productivity, and addressing income inequality.

These quantitative and qualitative benefits work together to deliver a virtuous circle of economic prosperity, business growth, and social well-being for all citizens—not only the wealthy. For example, the study found that 38% of cities deploying smart mobility solutions are bolstering customer satisfaction and 32% are improving productivity and delivery times for business. Likewise, 45% of cities deploying smart environmental and energy initiatives are improving citizen health, 44% are reducing pollution, and 43% are stabilizing energy prices, results that benefit all city dwellers.



Hyperconnected communities are the art of the possible—future cities that offer vast improvements in the quality of life for citizens and huge potential for efficiencies across government and the connected ecosystem.

William Baver, Vice President, Smart World Team, NTT DATA

On average, cities expect to increase their smart city spending by **14%** over the next year. Implementers will see the largest increase, at **21%**.



The path to a hyperconnected future



Developing a roadmap to go beyond smart city initiatives and become a fully connected city is key. Cities must have a clear idea of what needs to be accomplished based on the specific needs and problems of their community. A roadmap is more likely to attract technology partners and funding for projects and programs.

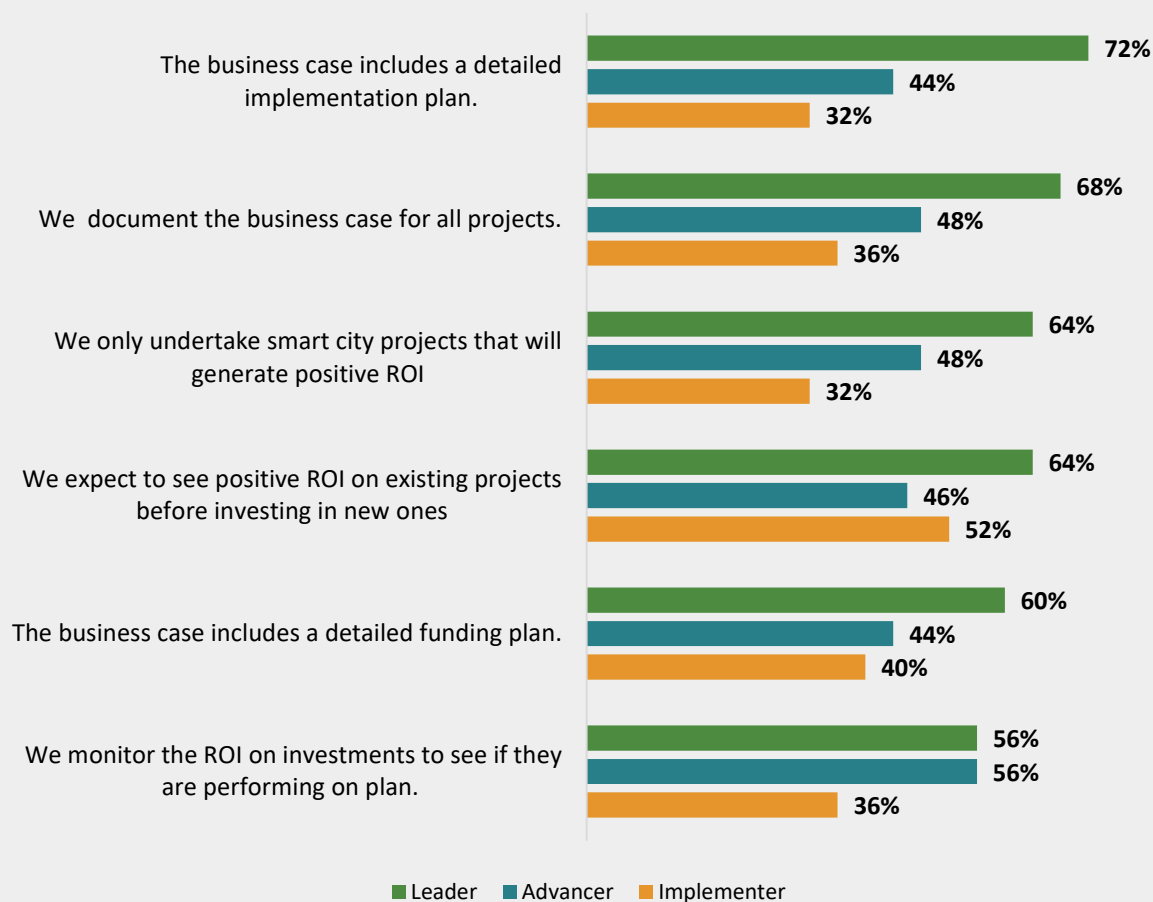
Joseph Viscuso, Senior Vice President and Director of Strategic Growth, Pennoni



Start with making the business case—and continuously monitor performance

To properly fund innovative city projects—as well as to assess the best investments—cities need to have a roadmap and business case. To do this, they must understand the return on investment, and analyze it systematically with the right metrics. Unfortunately, only about half of cities create a business case for all smart projects—although tellingly 68% of leaders do—and a similar percentage expect to see a positive ROI before investing.

Leaders make the business case and calculate ROI



Becoming a hyperconnected city is a journey that will constantly evolve as digital technologies advance. You won't be able to do everything at once, so start by setting priorities. Your needs assessment will drive this, helping you to clearly identify the return and value on each proposed investment. Working through these considerations will help you to isolate what's most important now and create a phased approach for other needs.

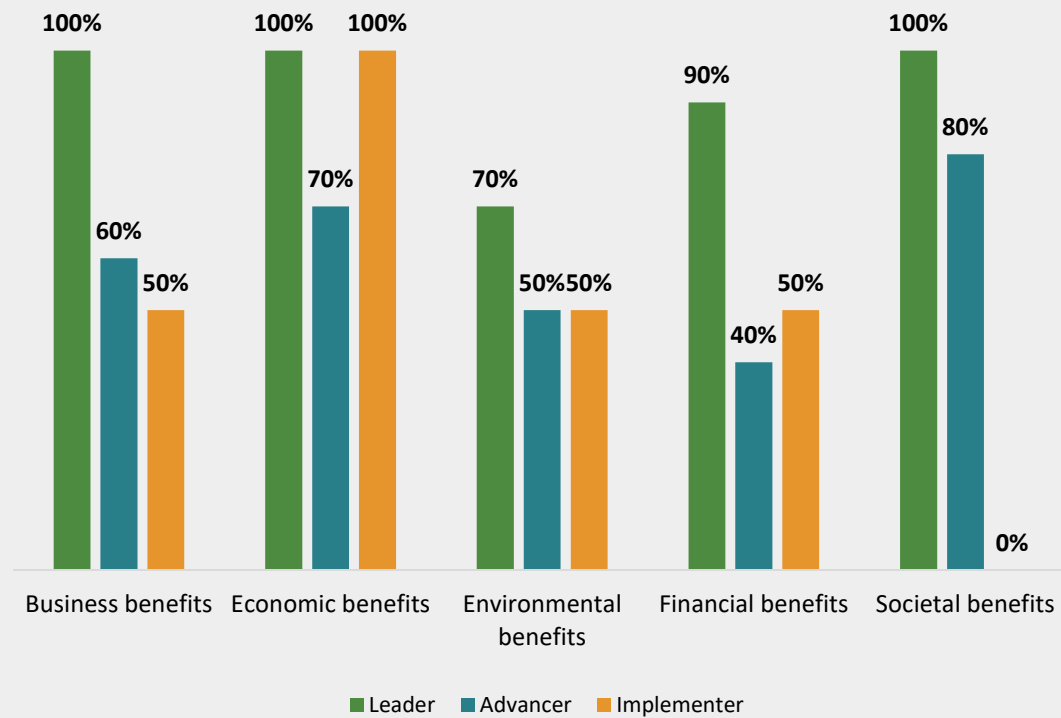
Wayne Best, Chief Economist, Visa



Make sure that you calculate the full benefits to your city

One reason that hyperconnected leaders report a higher ROI than less advanced cities is that they capture more of the benefits when making their calculations. Hyperconnected leaders typically consider societal benefits, such as reduced crime, and improved health and well-being. They also weigh the full business benefits, such as higher productivity, improved logistics, and greater e-commerce, and the complete economic benefits, such as increased economic growth and tourism. By contrast, only about one-third of implementers use anything except economic benefits in their calculations, and only about two-thirds analyze even those benefits consistently for their projects. There is also a dichotomy between cities in advanced vs emerging markets: cities in advanced markets always or often quantify societal (100%) or environmental benefits (67%), while only 43% of cities in emerging markets do so in both cases.

Benefits always or often included in ROI analysis



The value created by a smart city project can't be purely financial. It is also about bringing social benefits, not just to a few but to all citizens. The success of city initiatives depends on paying special attention to how to meet the needs of underserved communities.

Suparno Banerjee, Global Public Sector Lead, Enterprise, Nokia



Find the best way to organize your resources

While there is no one way to organize for success, our research uncovered general trends across several areas. Hyperconnected leaders tend to fully or largely centralize their staff. Nearly two-thirds of leaders do this, compared with 60% of beginners. None of the leaders take a fully decentralized approach, compared with 12% of beginners.

Moscow is a good example. A key reason for the success of its smart program was the centralization of the IT department, says Eldar Tuzmukhametov, head of Moscow’s Smart City Lab. “The decision to centralize the IT department of the whole city allowed us to completely transform the city within five to six years. If we kept going the way of different groups and different suppliers for

different departments, it would have taken us two or three times as long to do the same work.”

In addition, hyperconnected leaders typically use both internal and external staff to operate their smart city programs, and none rely only on external staff. The percentages are the reverse for implementers, which are more likely to outsource this function and less prone to use both internal and external staff. Curiously, beginners and leaders are equally likely to have a single person directing their smart city programs. But because of the importance of these programs, hyperconnected leaders are far more likely to have smart city directors reporting into the mayor’s office than beginners.

Organizing staff in smart cities

Organizational approach	LEADERS	IMPLEMENTERS
Centralized/largely centralized	64%	60%
Decentralized	0%	12%
Use of internal and external staff		
Both	88%	40%
External only	0%	32%
Smart city responsibility		
One smart city director	28%	28%
Reporting to mayor	71%	14%

Cities in **emerging markets** often take a different organizational approach than those located in **developed markets**.

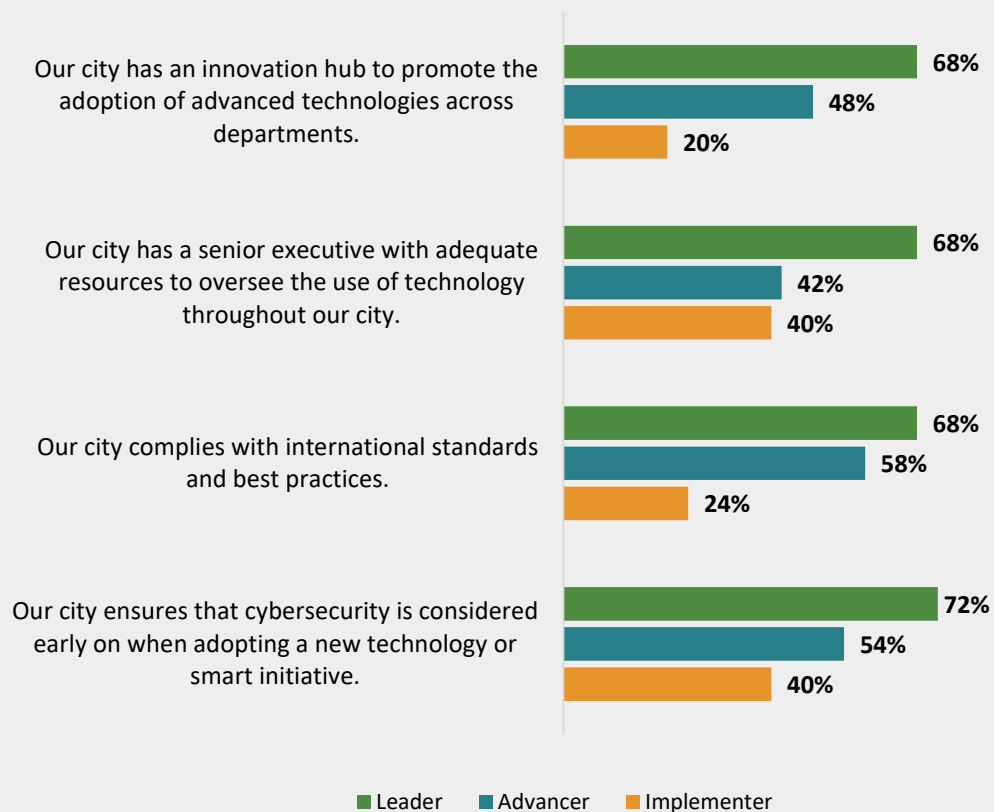
Only **19%** have one person in charge of smart city initiatives and **none** report to the mayor. And **51%** use just internal staff or just external staff.



Capitalize on advanced technologies

Hyperconnected leaders are more sophisticated in their use of technology than other cities. Almost three-quarters have an innovation hub to promote the use of advanced technologies, and even more understand the importance of cybersecurity when adopting new technologies. Almost two-thirds comply with international standards and employ senior executives with adequate resources to oversee use of new technologies. Another area that sets leaders apart is their higher use of AI: all leaders use robotic process automation, and only slightly less, machine learning. Leaders are also far more advanced in their use of computer vision, deep learning, and natural language processing.

Technology approaches for cities (% agree and strongly agree)



Use of AI technologies (% using today)

	LEADERS	ADVANCERS	IMPLEMENTERS
Robotic process automation	96%	82%	48%
Machine learning	88%	82%	56%
Computer vision	68%	54%	32%
Deep learning	56%	42%	24%
Natural language processing	44%	34%	16%

The many uses of AI

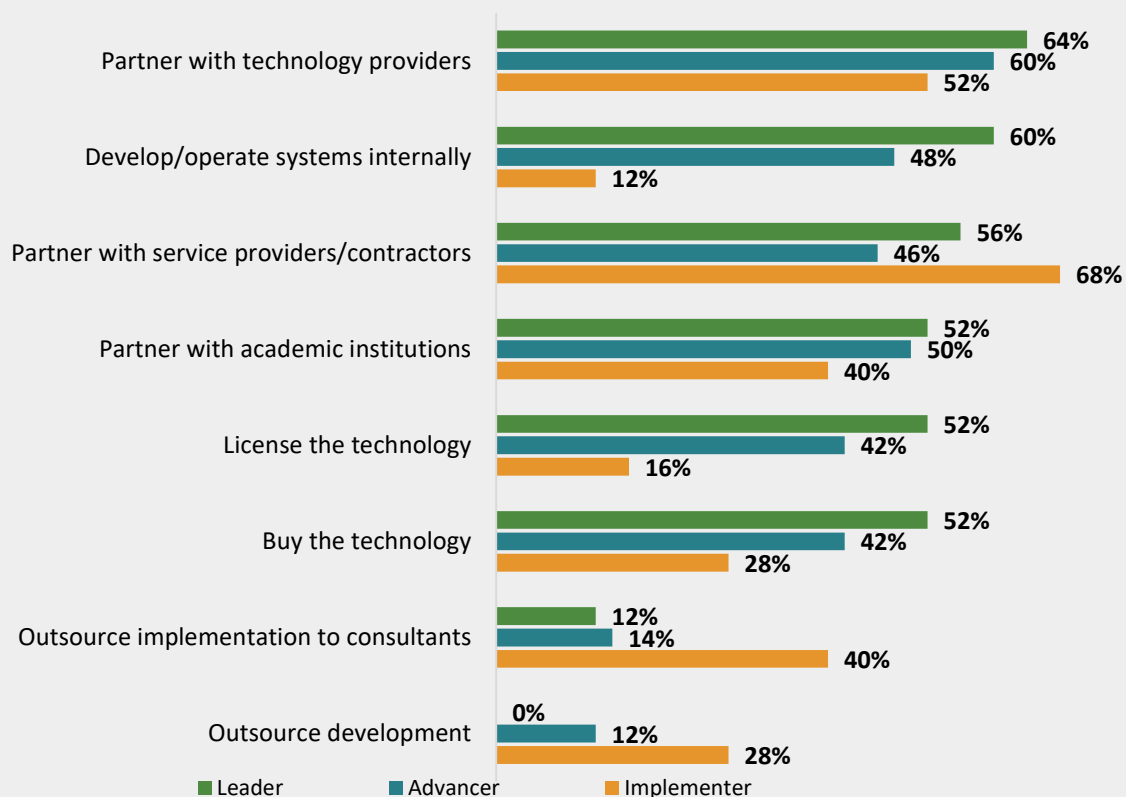
- New York: Locate and assess gunfire
- Moscow: Manage personal information
- Kuala Lumpur: Reduce city travel time
- Las Vegas: Mitigate cybersecurity risks



Use the ecosystem effectively

Hyperconnected leaders turn partnering into a best practice. Partnering often enables cities to do more with less resources, align strategic goals, and generate continuous improvements. At the same time, they are more self-reliant: they are more likely to develop and operate systems internally, and to buy or license technology, and less likely to outsource implementation or development.

Ways of acquiring technology (% using)



Whether in mobility, energy, or any other domain, delivering the promise of a smart, hyperconnected city will require a true ecosystem of participants. Neither governments nor the private sector can do it alone.

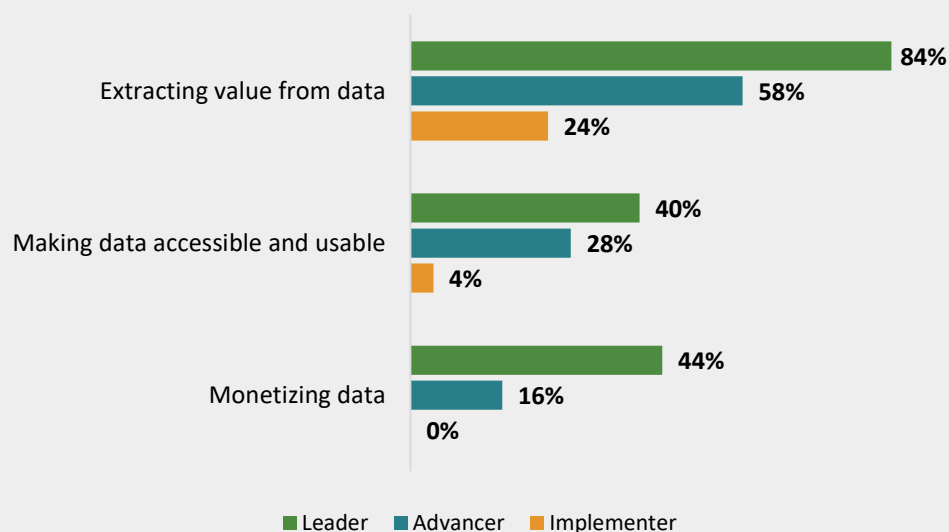
Rana Sen, GPS Managing Director, Deloitte



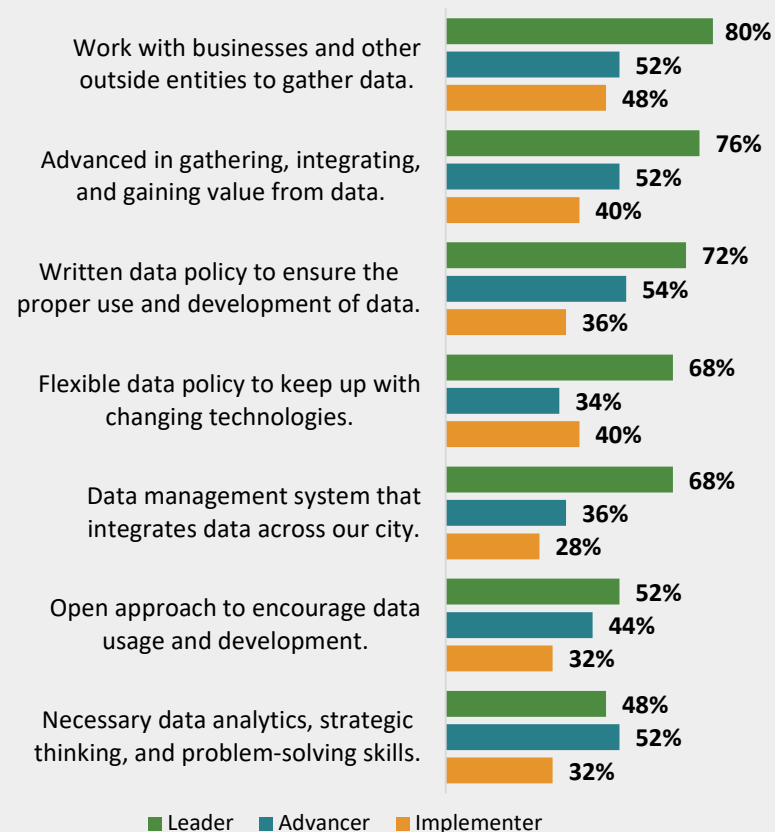
Generate more value from data

Hyperconnected leaders are well ahead of other cities in extracting value from data, as well as monetizing it, and making it accessible to businesses and citizens. Leaders are doing far more in most areas of data management. The vast majority are advanced in gathering, integrating, and gaining value from data, and pulling in data from outside the government. Leaders also have flexible data policies to keep up with changing technologies, along with written data policies to ensure the proper data use. Over half take an open data approach.

How leaders are getting more from their data



How leaders make their data work harder



On average, cities make **400** datasets available to the public, while leaders make an average of **620** available.

Ensure all citizens are engaged and connected

Hyperconnected leaders are highly sensitive to the needs of citizens and actively engage them in city issues. A large majority of leaders ensure that stakeholders know the value of smart city projects, stay engaged, and provide input. About two-thirds also take steps to ensure that disadvantaged populations, such as the poor, handicapped, or digitally illiterate, stay included and involved in smart city programs.

	LEADERS	ADVANCERS	IMPLEMENTERS
Reach out to stakeholders to demonstrate the value from project.	96%	46%	40%
Ensure city's shareholders are actively engaged in our smart city initiatives.	80%	48%	54%
Provide ways for citizens to find out about city initiatives and how they can provide input.	72%	62%	28%
Identify relevant stakeholders and their potential roles when planning smart city initiatives.	72%	48%	44%
Conduct audit of social groups in danger of exclusion as city services become digitized.	68%	54%	8%
Take steps to ensure that disadvantaged populations are involved in the process.	60%	44%	40%
Use gamification and other incentives to increase citizen engagement.	52%	36%	24%



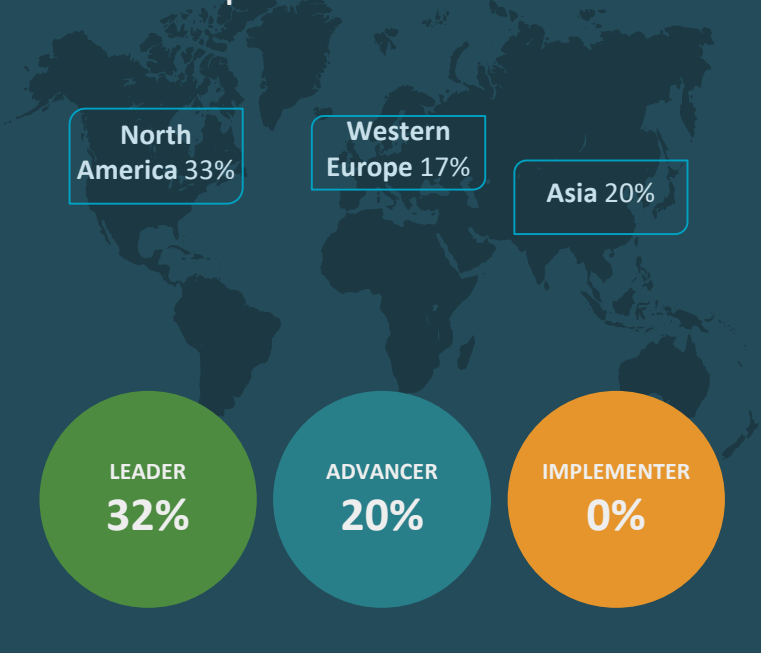
Citizens have a key role in defining and validating outcomes from smart city solutions, using the technologies, and providing feedback. They need to be a voice for smart city innovation, actively engaged with their government leaders.

William Baver, Vice President, Smart World Team, NTT DATA

The rise of CCXOs

To stay connected to citizens, hyperconnected leaders are starting to appoint chief citizen experience officers (CCXOs). The CCXO is responsible for the end-to-end experience of citizens, ensuring that city websites, call centers, and mobile apps are designed with their needs and values in mind. In some cities, this entails responsibility for the experience across the urban landscape, from transportation, education, and healthcare to community events, housing, and parks and recreation.

Percentage of world cities with Chief Citizen Experience Officers



Moscow's connected citizens

The city of Moscow provides an instructive example of best practice relating to citizen engagement.

Eldar Tuzmukhametov, head of Smart City Moscow, built a platform that facilitates two-way information flow. The system collects a variety of data from citizens, such as their opinions on current services and the ones they want most.

“We deliver services to citizens, but we also want to hear what they think, what they do, and what they need.” To ensure that all citizens—particularly older ones—benefit from its smart initiatives, Moscow also developed a project to train people on using digital technology, websites, and smart apps.

The Moscow platform offers almost 300 public services for citizens and businesses through a website and mobile apps. These include:

- *Our City*, a website and app, allows citizens to file complaints to the city. Over 1 million citizens use the website, and over 2 million complaints have been addressed.
- *Active Citizen* allows citizens to vote on city issues. Active Citizen has almost 2 million users. Over 2,600 polls have been conducted, and in 1,500 of those cases the decisions have been implemented.
- *Crowd*, a website and app gives citizens a discussion board to propose ideas and making suggestions on how to improve community projects. Crowd has 130,000 users who have proposed 84,000 ideas.
- *Moscow Online School* connects schools with an online learning platform. The platform includes Wi-Fi, interactive screens, electronic diaries, and tablets. With help from a \$300 million investment, it has reached 980,000 students and 65,000 teachers in over 700 schools.

Smart City Moscow services are just as useful for business owners. For example, an app has sped up permits and approvals for businesses dramatically, says Tuzmukhametov. “In 2010, it would have taken a restaurant in the center of the city from 1 to 3 months to get approval to use the street for tables in the summertime. If the restaurant applied in May, by September when the response arrived, the season would be over. Now it can do this through the electronic portal, and it takes only a few days,” he says.

68% of Moscow's **12.5 million** citizens—*almost its entire adult population*—use the city's website.

Moscow offers **300** public services through its website and provides nearly **1 billion** services throughout the year.

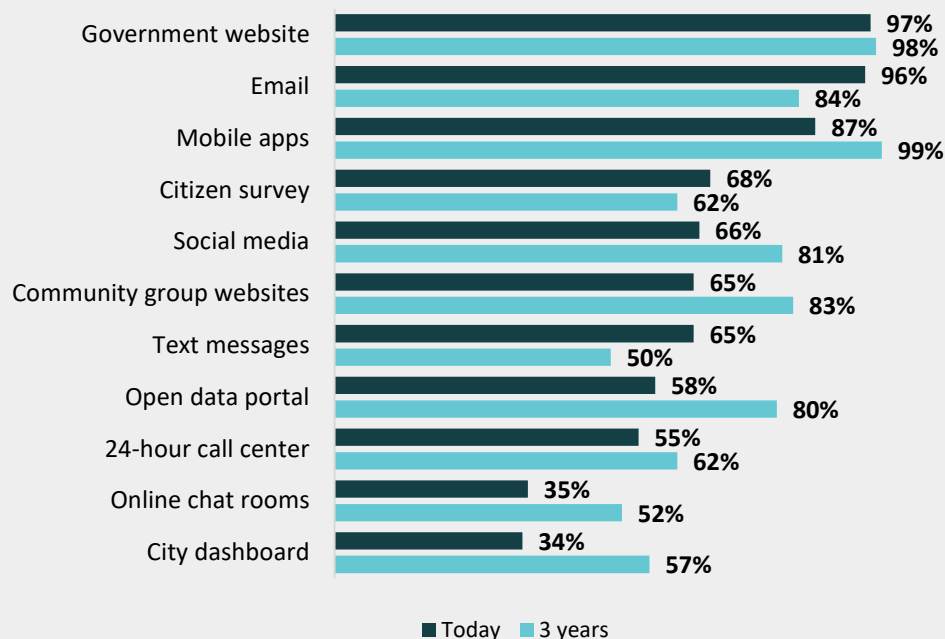


Use an omni-channel approach to communicate with citizens

Hyperconnected leaders communicate effectively with citizens through multiple channels. Not only does cross-channel communication help to reach and engage residents, but it provides increased citizen input for decision making. While government websites and email are now table stakes for nearly all cities, hyperconnected leaders are distinguished by their use of community websites, open data portals, 24-hour call centers, online chat rooms, and city dashboards. They know that users want to shift seamlessly from channel to channel, as they do when dealing with private sector companies.

Over the next three years, cities plan to escalate their use of social media, community group websites, open data portals, online chatrooms, and city dashboards. At the same time, they will moderate their use of citizen surveys, text messages, and email.

Channels in use today and in three years



Channels in use today by maturity level

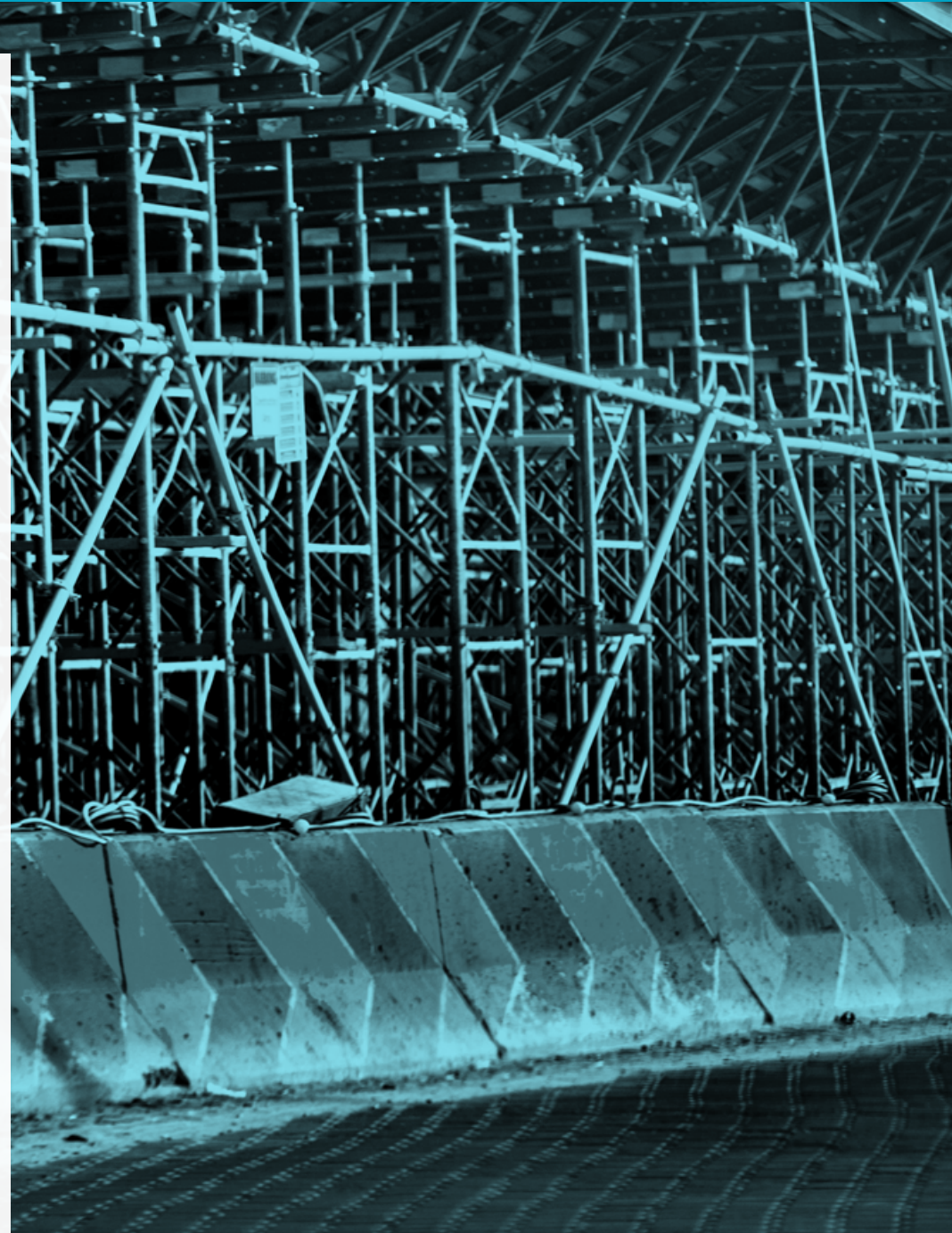
	LEADER	ADVANCER	IMPLEMENTER
Government websites	100%	94%	100%
Email	96%	100%	88%
Mobile apps	96%	92%	68%
Open data portals	92%	50%	44%
Social media	88%	70%	40%
Community group websites	84%	62%	52%
Citizen surveys	80%	66%	60%
Text messages	76%	62%	60%
24-hour call centers	72%	52%	44%
Online chat rooms	72%	32%	8%
City dashboards	60%	28%	20%

Overcoming roadblocks



Public leaders understand that digital transformation is the key to success. However, many struggle with how to accomplish it when they are faced with complex infrastructures, multiple platforms, the need for different types of data, and customized technological applications. Across the board, the research tells us that the cities that overcome these challenges are the ones that recognize the greatest benefits.

Susan Wilkinson, Director, Business Strategy, Smart Cities, Microsoft



Cities face common obstacles

Cities must overcome similar obstacles before they can gain the full benefits of a smart, hyperconnected ecosystem. Chief among these is ensuring citizen and stakeholder support and keeping up with the needs of citizens and businesses.

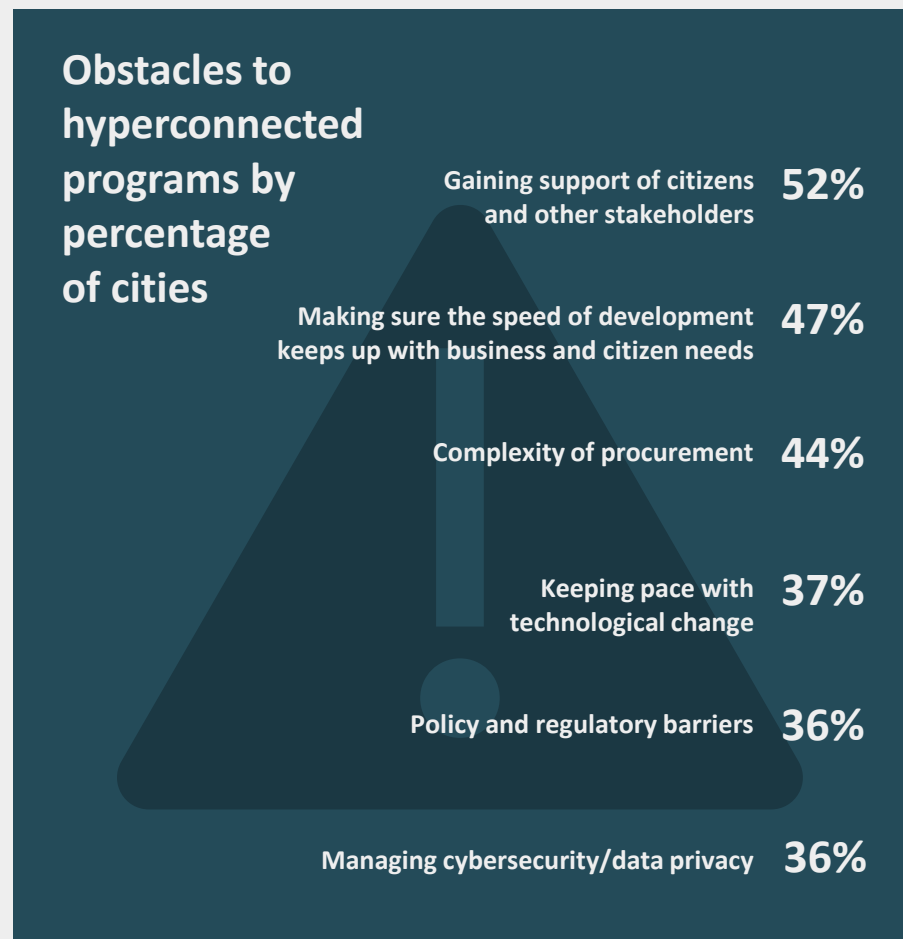
Cities also face policy and regulatory hurdles, both those decreed by higher levels of government and those self-imposed. These include complex procurement procedures that may block innovative projects and hinder partnering and outsourcing.

Yet another major challenge is keeping pace with technological change—while at the same time managing cybersecurity and data privacy. These two issues are intertwined: as cities adopt new technologies their exposure to cyberattacks increases.



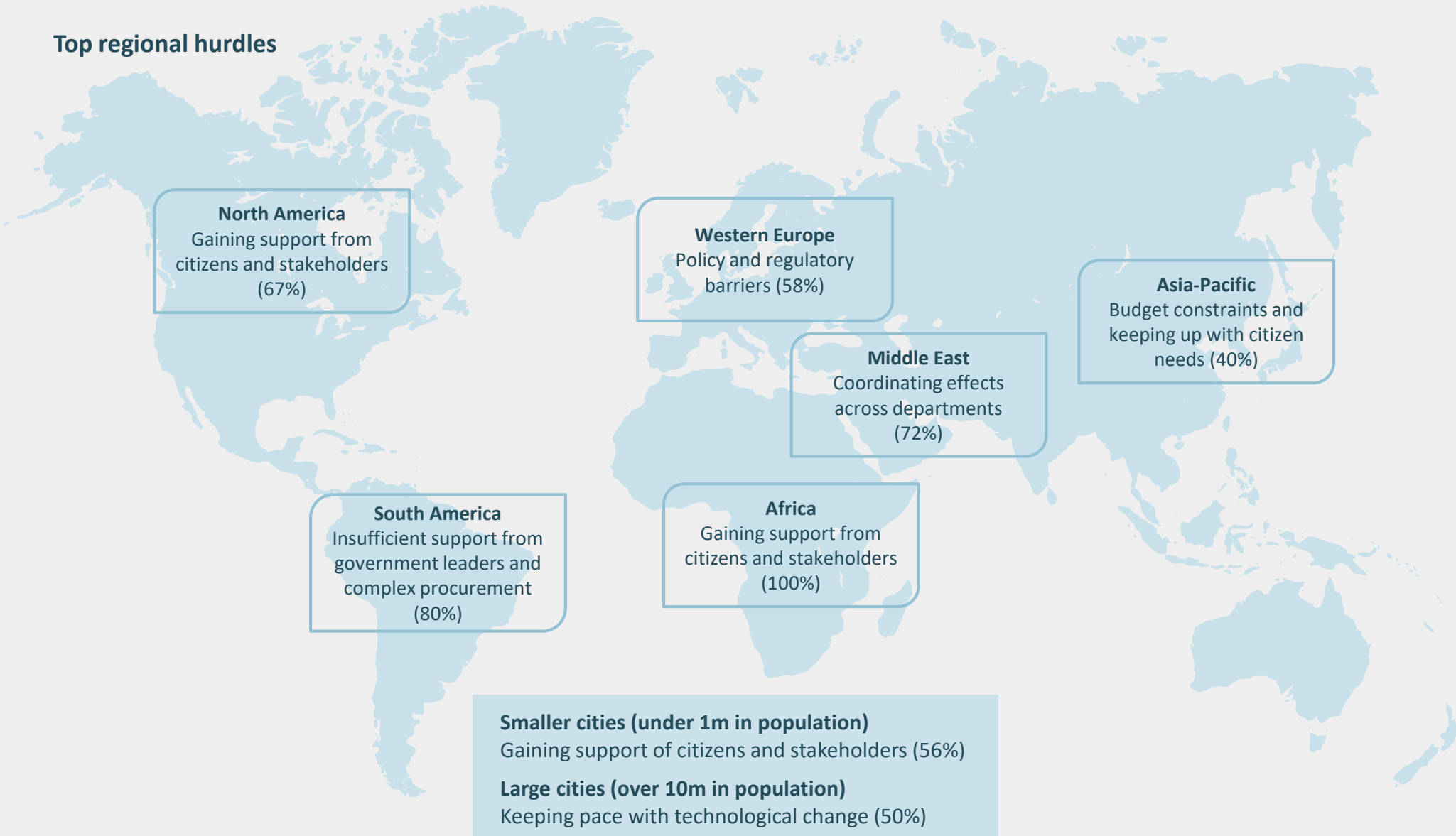
There are many concerns about surveillance and privacy — and rightly so. We need to work on how we manage the information about these things, and how we educate youth and regular citizens.

Professor Eugenie Birch, Co-Director,
Penn Institute of Urban Research



How obstacles vary by cities in different regions

Top regional hurdles



Gaining support is challenging, but essential

The recent backlash to facial recognition in San Francisco and 5G towers in Brussels vividly demonstrates the problem with failing to gain citizen and stakeholder support. Despite the importance of gaining support, cities generally do an inadequate job of ensuring that urban stakeholders are aware of smart initiatives. Business leaders tend to be knowledgeable, while city employees, citizens, and even elected officials, are less informed. Cities need to overcome the current disconnect between what cities are doing and what citizens think they are doing, otherwise there is a risk of a “techlash”. It is particularly challenging in lower income markets (75%), where citizens often see smart initiatives as more beneficial for the elite. Effective communication is also crucial in overcoming another major challenge: keeping up with business and citizen needs.

Stakeholders who are very to extremely familiar with smart city activities.



BUSINESS LEADERS
88%



ELECTED OFFICIALS
65%



CITY EMPLOYEES
40%



AVERAGE CITIZENS
32%



Many smart city solutions have failed because their focus has been on technology rather than people. We must focus less on the technology and more on how to use it to make lives better for people and to solve the problems of urban life.

Jeremy Kelly, Director, Global Research Programs, JLL

Leaders do a better job...



80% of leaders keep their citizens informed of smart city initiatives, vs 46% of others



96% of leaders reach out to stakeholders to demonstrate value, vs 42% of others



60% of leaders take steps to ensure that disadvantaged populations are involved in the process

How Barcelona and Stockholm keep citizens on board

Barcelona and Stockholm are two cities that have proactively worked to avoid potential “tech-lash” to certain technology initiatives by promoting citizen engagement.

Barcelona does this to a large extent using Decidim.Barcelona, a digital democratic platform that allows citizens to debate urban solutions, participate in decision making, and shape future policies. The tool, which is now used by 400,000 citizens, is put together using open-source software and open code, so that it can be reused and improved upon. Francesca Bria, Barcelona’s chief technology and digital innovation officer, has publicly called for “a new social contract for the digital age,” and the need to assert the “digital sovereignty” of its citizens so that its city serves the interest of all residents. Barcelona is also making city data available to the public, regarding it as a utility function, Bria has said.*

How Stockholm builds trust

Stockholm is also rethinking its social contract with citizens as it rolls out new technology. Petra Dalunde, COO for the Urban ICT Arena at the Kista Science City, Stockholm’s technology and innovation hub, says that the way Kista has gone about a small-scale implementation of urban drones is emblematic of Stockholm’s overall approach. “If we want this to be successful, we have to show how it adds value for citizens and also make it possible for them to interact with the technology and be a part of the design,” she says. “It’s a very large pedagogical effort that we need to embrace.”

So far, the outreach has been to a small group, but as the city expands its use of drones, it will be much wider, says Dalunde. “We will have something for all types of citizens. We would really like to know what citizens really are asking for, what things are working, and what things don’t work. The contact between citizens and the city should be natural. It’s a question of building relationships to create trust.”

Dalunde explains that using Kista to pilot the drone effort and establish trust with residents helps Stockholm avoid making an early wrong move. “It’s easier if the city doesn’t take the lead here,” she says. “If we are successful with the drone project, my hope is that Stockholm can use the same methods and approach towards citizens to solve other trust issues.”

*Thornhill, John, “Smart cities still need a human touch,” *Financial Times*, August 5, 2019



Listening to communities about their needs and then incorporating their ideas into solutions is crucial—often the best thinking come from residents.

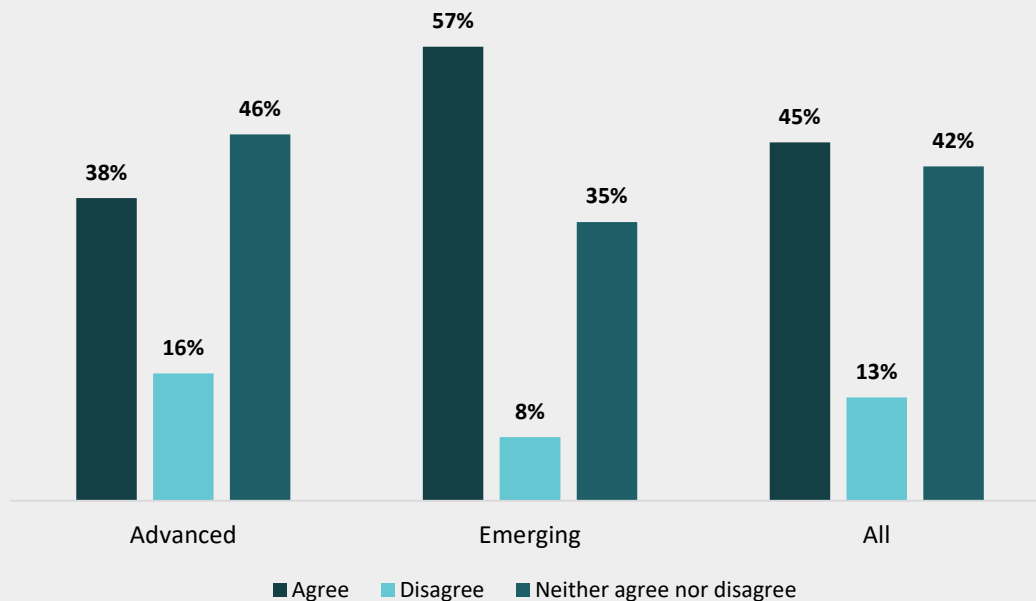
Nancy MacDonald, Vice President,
Urban Places, Stantec



Policy and regulations can be barriers

Some of the largest hurdles that cities face in implementing smart programs are regulatory. Regulations regarding land use, privacy, and cybersecurity may slow innovation—even though they are necessary. For example, the EU’s General Data Protection Act (GDPR), which California has emulated in its data privacy legislation, may hinder cities in the collection and use of data. Cities in emerging economies find regulation more problematic than those in advanced markets. City leaders often find that legislators are open to discussions on digital innovation when framed by the economic and social benefits it will bring.

The regulatory environment hinders our city’s ability to use, develop and manage data.



Making the business case



Working with regulators, particularly in emerging markets, can help vault regulatory hurdles. For example, Gerald Maduabuchi, Business Development Manager at Uchald Integrated in Nigeria, suggests that conducting consultations with stakeholders and research into industry best practices can help regulators rethink their policy positions. Eldar Tuzmukhametov of Moscow City Lab believes that his city’s effective interaction with the federal government accelerated progress on hyperconnected initiatives. “Each of our projects were strongly supported by legislative changes,” according to Tuzmukhametov.

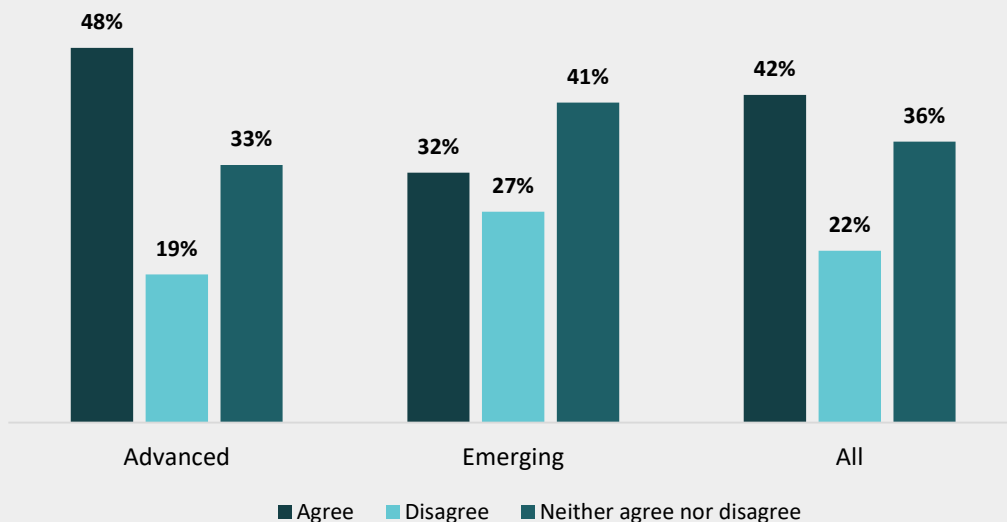


Procurement complexity can stymie innovation

Rigid procurement rules, outdated mandates, and inapplicable thresholds often stall or block projects. These policies can make innovative partnerships with vendors and the creation of effective ecosystems difficult, if not impossible. Standard procurement processes can be restrictive, time-consuming, and inflexible. Searching for the right partner through a competitive RFP process may not even make sense when looking for a solution that does not exist yet. As a result, some cities end up purchasing technologies that are out of date or out of scope.

Generally, cities in advanced economies find procurement policies more burdensome than those in emerging economies. Hyperconnected leaders are better equipped than others to cope with procurement complexity. Only one-third see procurement as an obstacle to smart city programs, compared with about 45% of others.

Procurement hinders adopting new technologies and business models



Coping with procurement barriers

Hyperconnected cities use different strategies to alleviate their procurement problems around new solutions. One is to take a **modular approach**, often in conjunction with urban innovation labs, partnerships, or incubators. Such an approach breaks down the procurement process into pieces, allowing the city to call on vendors to test and demonstrate solutions before moving to an RFP. This minimizes the risks of choosing the wrong technology and gives cutting-edge start-ups a chance. Kansas City is taking this approach with its Innovation Partnership Program, as is Pittsburgh with its PGH Lab, which is adding advanced data analysis of proposals to the process.

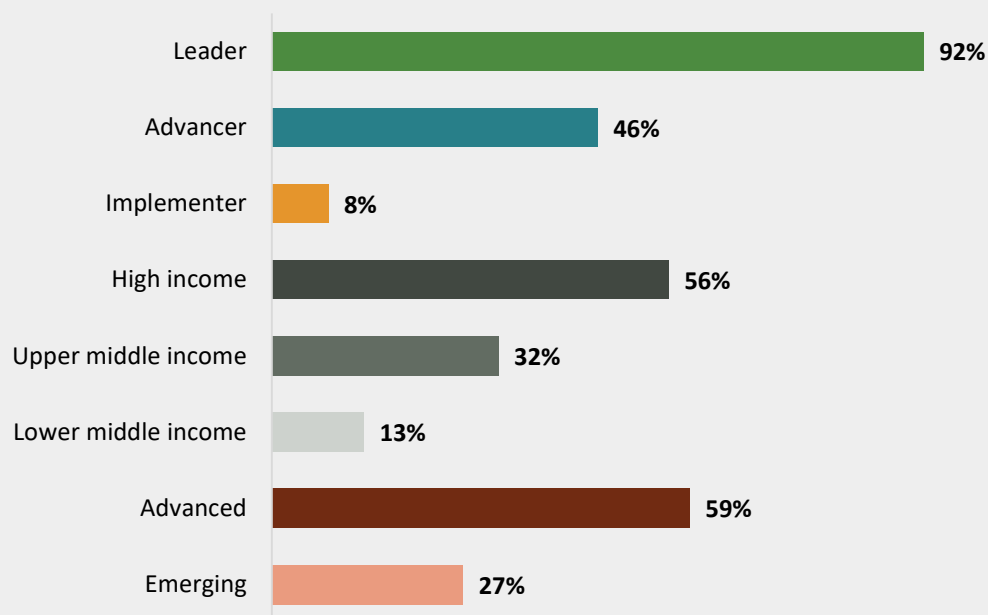
Some cities are going to the next level by following a **non-prescriptive procurement process**. This is where a city identifies and frames the problem and calls for solutions, rather than dictating the technology and solutions. Philadelphia is doing this with its FastFWD process.

Yet another strategy is to attack the obstacle directly with **procurement reform**—something that major cities, such as Chicago, Boston, and New York, are undertaking. Many of these efforts involve greater standardization and transparency—such as Chicago’s online publication of every contract, with both losing and winning bids.

More innovation also means more cyber risk

Keeping pace with technology is a pain point for more than a third of cities, but in overcoming that challenge, they face a new problem—ensuring that they are not more vulnerable to cyberattacks. While only a substantial minority of cities have taken steps to ensure they keep up with technological development, happily, more than half are mindful of the cybersecurity implications. Unfortunately, that doesn't mean they have good cyber defenses: less than half of the cities in our survey consider themselves to be well prepared for a cyberattack. Cities that are less advanced in hyperconnectivity, lower income, or located in emerging markets are particularly unprepared.

Cities well prepared for cyberattacks



Cybersecurity vulnerabilities



Ensuring cybersecurity is complicated by the array of potential vulnerabilities across an urban ecosystem. Over half of the cities surveyed said their physical and digital security systems, payment and financial systems, and IT infrastructure were vulnerable to cyberattacks. For implementers, the vulnerabilities are even greater.

Physical and digital security	55%
Payment and financial systems	54%
IT infrastructure and telecommunications	51%
Mobility and transportation	40%
Public safety, health, and well being	33%
Data and analytics	26%
Governance and funding	25%
Environment and sustainability	18%
Buildings, schools, public spaces	11%
Water and waste management	10%
Energy and electricity	8%

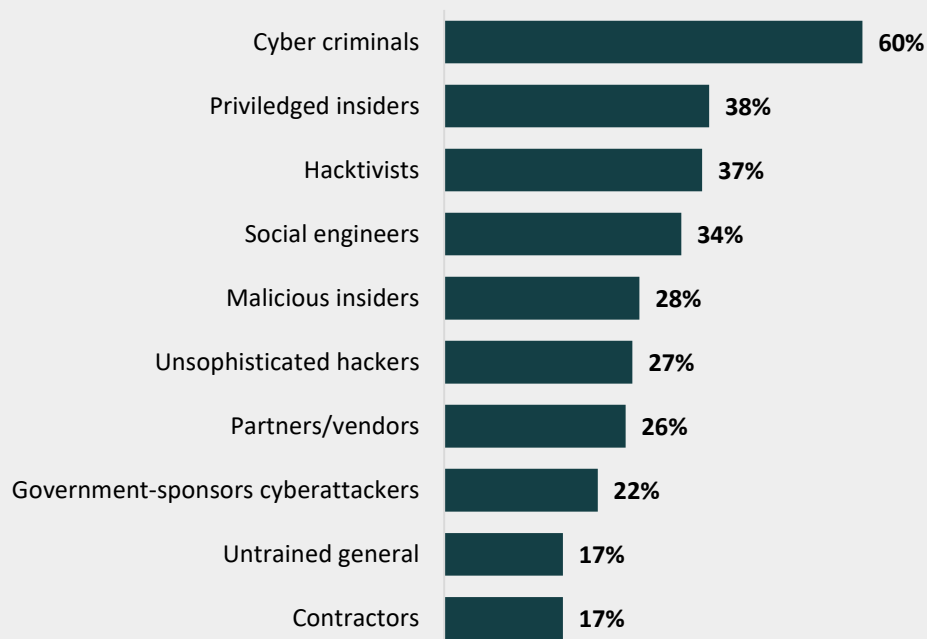


For cities, cyber attacks are coming from many directions

From Baltimore to Atlanta to Dublin, Stockholm, and Johannesburg, cities around the world are increasingly under cyber attacks. The biggest threat is coming from cybercriminals who often see cities as easy targets because of their lack of cybersecurity systems and skills. And the threats are not just coming from outside the city, but also from within because of risks caused by privileged insiders and untrained staff, as well as malicious insiders.

Cities are now seeing the largest impacts from attacks through shadow IT (systems built and used within organizations without explicit approval) and malware and ransomware. Ransomware attacks are particularly on the rise in the US, with Baltimore, Lake City, and Atlanta just some of the recent victims. Over the next three years, cities expect attacks through new technologies (such as AI and blockchain) to have the largest impact.

Threat actors posing the largest risks



Types of attacks cities are experiencing

Attacks through shadow IT	38%
Malware/spyware/ransomware	36%
Attacks through physical assets or through cyber to physical assets	32%
Attacks through partners, customers, vendors	32%
Attacks through legacy IT infrastructure and applications	31%
Attacks through embedded systems (firmware, IoT, etc.)	30%



Cybersecurity is essential for two reasons. First, digital identity is fundamental in a smart city and therefore issues of privacy and trust are key. Second, digital services and the whole city depends on the resilience of its infrastructure.

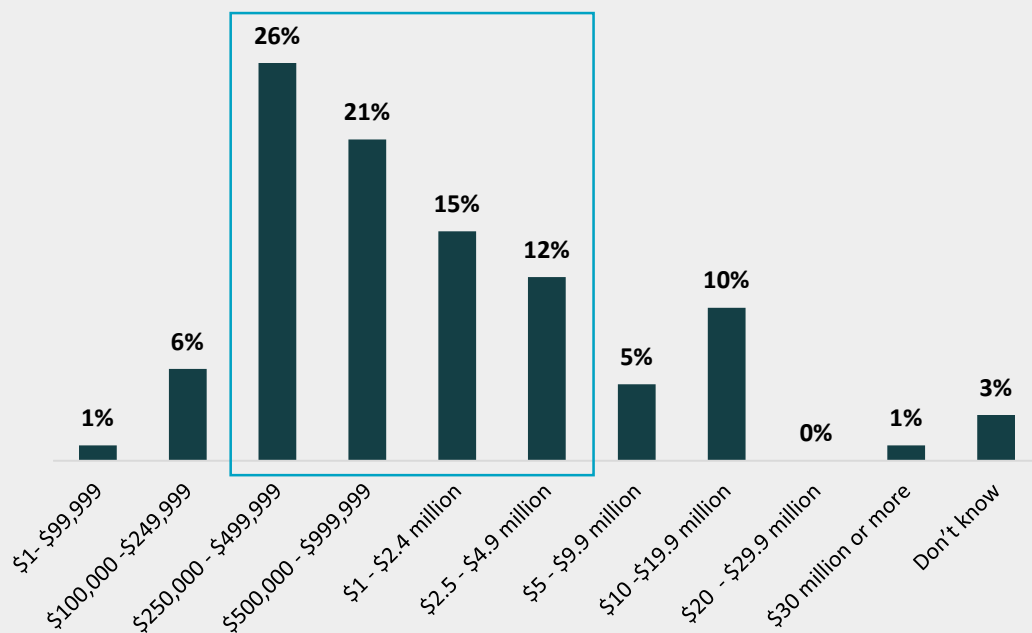
Dr. Joan E. Ricart, Co-Academic Director, IESE



Cybersecurity losses in cities are often high

The costs of failing to address cybersecurity vulnerabilities can be enormous to cities. The mean annual cybersecurity loss for cities across the world was \$3.2 million—not an insubstantial sum for a tight government budget. Most cities’ annual losses range from \$250,000 to \$4.9m, and some 11% had losses over \$10m. Unfortunately, the more digitally advanced a city is, the higher its cybersecurity losses—even though advanced cities tend to be better prepared to defend against attackers. Losses also tend to rise in absolute terms with a city’s size, but on a per-capita basis they fall considerably as city size increases from \$4.81 per capita for cities with less than 1 million people to \$0.66 per capita for cities with more than 10 million people.

Annual cybersecurity losses



Annual cybersecurity losses by different city segments

By maturity	Total	Per capita
Leader	\$6,170,000	\$3.56
Advancer	\$2,030,000	\$1.96
Implementer	\$2,815,000	\$2.05
By preparedness against attacks		
Well or very well prepared	\$4,930,000	\$3.42
All others	\$1,730,000	\$1.44
By population size		
< 1 million	\$2,230,000	\$4.81
1 million to 5 million	\$2,560,000	\$1.04
5 million to 10 million	\$3,525,000	\$0.54
> 10 million	\$7,740,000	\$0.66

How cities are responding to higher cyber risks

To cope with the increased risks from cyber attacks, cities are spending more on cybersecurity and increasing their staffing. Most cities have increased budgets by 1% to 10% over the past three years and just over a quarter have done more. Over the next three years spending will grow even faster. In addition, around half of cities (72% of leaders) plan to create a pool of cybersecurity talent that can be used to support departments across the city. Almost half of cities plan to bolster their cybersecurity departments by providing training to existing staff. Most cities are keeping the function in-house, with only 23% planning to outsource and less than 40% hiring in outside consultants. Interestingly, leaders spend twice as much as implementers on cybersecurity.

62%
HIRE MORE
CYBERSECURITY
STAFF



51%
CREATE A CENTRAL
POOL OF TALENT



46%
PROVIDE STAFF
TRAINING



38%
RECRUIT SENIOR
CYBERSECURITY
EXECUTIVES



37%
AUGMENT STAFF
BY USING
OUTSIDE
SPECIALISTS



23%
OUTSOURCE
CERTAIN
FUNCTIONAL
AREAS



Cybersecurity spending

How has your spending in cybersecurity changed over the last three years?

58%
1% to 10% increase

28%
Over 10% increase

How do you expect it to change over the next three years?

40%
1% to 10% increase

37%
Over 10% increase

Current annual cybersecurity spending by city segments

By maturity	Total	Per capita
Average	\$391,575,000	\$160
Leader	\$681,175,000	\$150
Advancer	\$346,000,000	\$190
Implementer	\$175,530,000	\$105
By preparedness against attacks		
Well or very well prepared	\$519,480,000	\$230
All others	\$311,000,000	\$95
By population size		
< 1 million	\$146,750,000	\$285
1 million to 5 million	\$231,585,000	\$95
5 million to 10 million	\$695,338,000	\$85
> 10 million	\$1,070,000,00	\$65

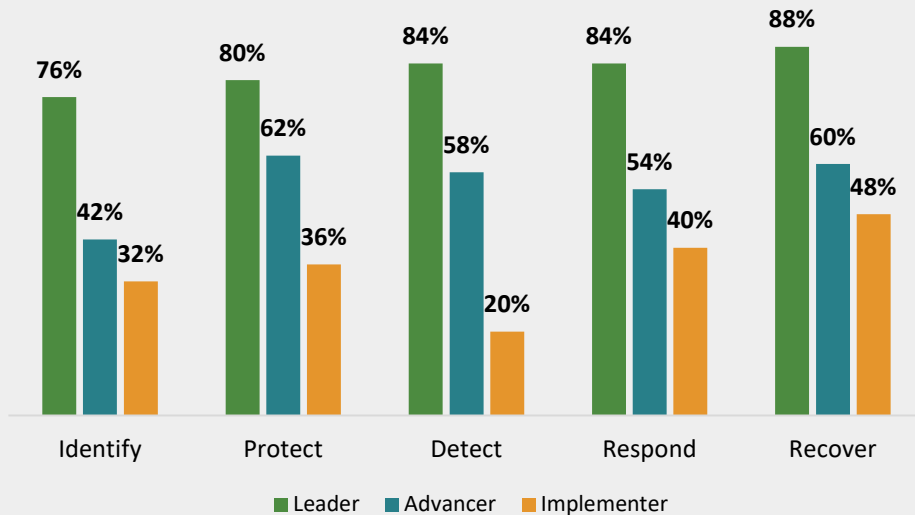


Cities should measure progress against a cybersecurity framework

To mitigate cybersecurity risks, cities are adopting cybersecurity frameworks that provide a maturity score of a city’s cybersecurity effectiveness. One such framework is the California Cybersecurity Maturity Metrics program now being used by cities across the state. Built on the National Institute of Standards and Technology (NIST) framework, the metrics address cybersecurity policies, processes, and governance in five key categories: (1) Identify: Governance and , processes for identifying data/system vulnerabilities; (2) Protect: Securing systems through safeguards such as account management, encryption and system configurations; (3) Detect: Network and end-point monitoring; (4) Respond: Incident response plans and testing; and (5) Recover: Technology recovery plans and communication.

To understand the progress that cities are making in cybersecurity, we asked cities to tell us their progress against the five NIST categories. More than half of hyperconnected leaders consider themselves to be mature or leading in all 5 NIST categories. Only 40% of cities are advanced in the identify phase, which is vital for understanding a city’s assets that are most vulnerable to cyber attack. While the percentages are higher for the other metrics, there are still many cities that are still in the early stages of detecting, protecting, and responding to cyber risks. Cities that are implementing hyperconnected programs are particularly behind in the cybersecurity programs, as are cities in emerging markets. Perhaps that is why cities are seeing high losses from cyberattacks.

Cities that are maturing or advanced by NIST activities



AI technology has the power to amplify human ingenuity and extend our capabilities so we can achieve more. When made accessible to everyone, AI will transform industries, make us more productive, and help solve society’s biggest challenges.

Susan Wilkinson, Director, Business Strategy, Smart Cities, Microsoft



The funding challenge

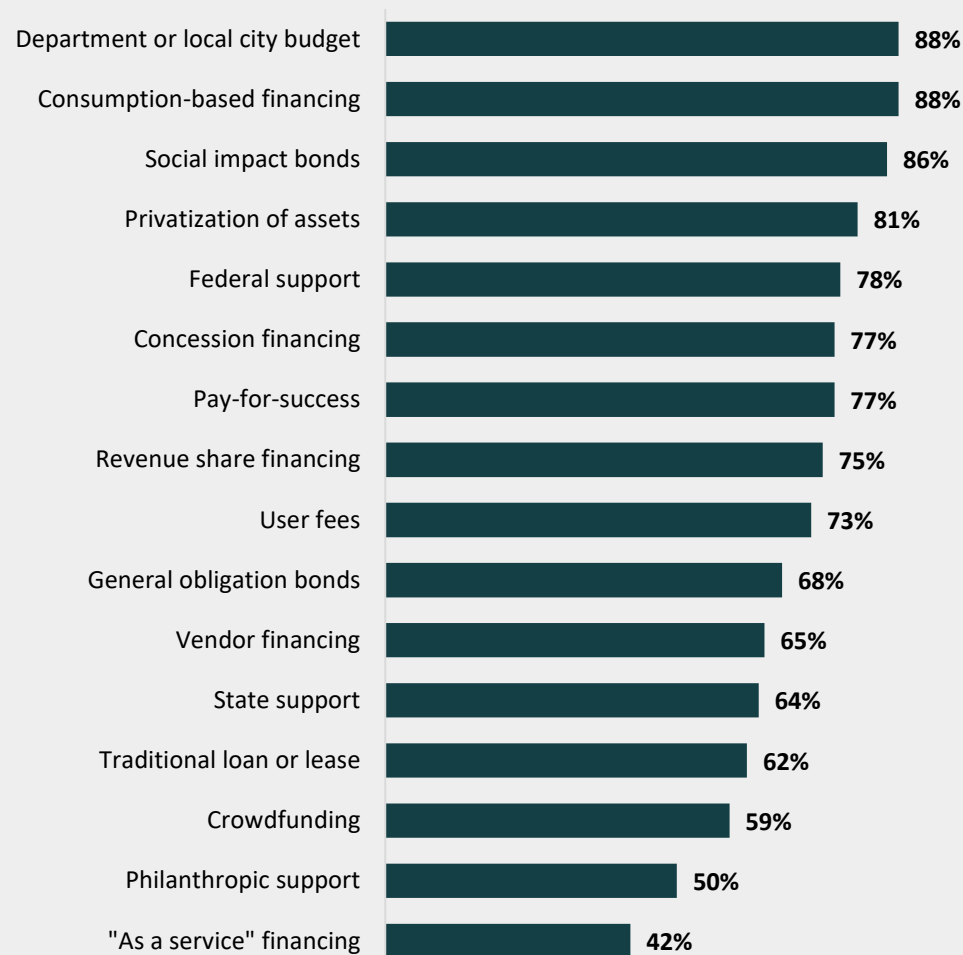
While funding smart city projects is more of an obstacle for cities with lower income—50% cited high implementation costs and budget/financing constraints—finding the money is nonetheless a challenge for all. Cities are using many ways to finance projects, from straight funding from the city’s budget and national government grants to more innovative techniques, such as consumption-based financing, social impact bonds, privatization of assets, and concession financing.



Finance is absolutely the biggest hurdle. Governments do not have enough capital to fund many smart city initiatives. This results in a diverse range of small smart city projects in ‘silos’ and, in most cases, ones that have failed to ramp up into larger, impactful projects. Governments need to attract private investors, in the form public-private partnerships into large, impactful projects worth investing in and showcasing to other cities to learn and benchmark.

Chungha Cha, Co-founder & Chair,
Re-imagining Cities Foundation

% of cities using following funding mechanisms



Funding solutions vary by urban area

While departmental and consumption-based financing are regularly used for all urban areas, some funding solutions are more geared to particular sectors. For example, social impact bonds are more often used in connection with environmental and safety programs. Revenue share financing, where contractors pay a share of revenue on services they build, is most frequently used in transportation, while privatization is more common for energy and the public safety.



Cities have tremendous room to experiment with multiple innovative financing models like pay-for-performance, share value capture, social or green impact bonds, various types of public-private partnerships, and data and asset monetization through things like road user charging or smarter curb management. Procurement and innovation models are changing, and we are just beginning to understand both the financial and non-financial opportunities.

Steve Hamilton, Senior Manager, Deloitte

Transportation		Public safety	
Consumption-based financing	44%	Federal support	43%
Department or local city budget	42%	Consumption-based financing	42%
Federal support	40%	Department or local city budget	41%
Revenue share financing	36%	Privatization of assets	37%
Concession financing	33%	Social impact bonds	35%
Energy and water		Governance	
Consumption-based financing	47%	Department or local city budget	44%
Pay-for-success	43%	Consumption-based financing	40%
Department or local city budget	40%	User fees	39%
Privatization of assets	39%	Federal support	38%
User fees	34%	Concession financing	29%
Environment			
Department or local city budget	47%		
Consumption-based financing	41%		
Social impact bonds	38%		
Federal support	35%		
Concession financing	32%		



What performance results can you expect?



For cities looking to implement smart projects, there are numerous approaches to map out ROI, and both public and private sectors have a role to play. Whether it's increasing efficiency to better manage revenue from utilities, or prioritizing accessibility to increase equity, there is a strong case to be made that includes financial and social impact as outcomes.

Nancy MacDonald, Vice President, Urban Places, Stantec



How we estimated ROI

As part of the survey, we asked city leaders to estimate the ROI achieved from hyperconnected projects deployed in their city. These estimates were self-reported and represent an order-of-magnitude return on different investments. As such, they provide a useful benchmark to compare the relative returns on investments (e.g., investments in digital transit payment systems, on average, generate greater returns than investments in predictive maintenance programs).

The ROI estimates likely represent a lower-bound estimate of the potential returns. Many of the social, health, environmental, and business benefits are difficult to quantify. Such qualitative benefits include creating new business opportunities, filling talent gaps, improving public health, reducing crime, boosting productivity, and addressing income inequality.

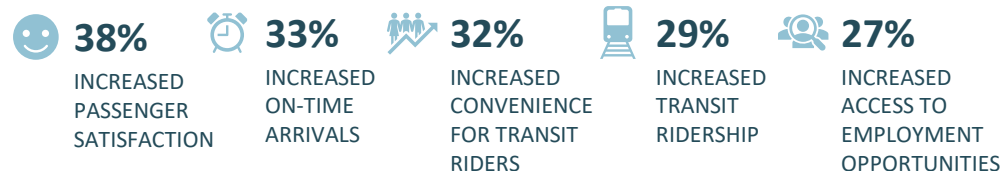
In the following slides we present the average ROI across all survey respondents as well as the average ROI for the hyperconnected leaders.



Public transit

Public transit projects—which offer large benefits, particularly for quality of life—are often among the first that hyperconnected cities tackle. Hyperconnected leaders are well ahead of other cities both implementing smart public transit solutions and the ROI they are achieving. Almost all leaders have adopted real-time public transit apps and digital payments, and most are moving to adopt technologies that build on these investments, such as open-loop payment systems and mobility-as-a-service apps. Public transportation investments also generate qualitative benefits, which particularly help lower income groups.

Main benefits of public transit initiatives



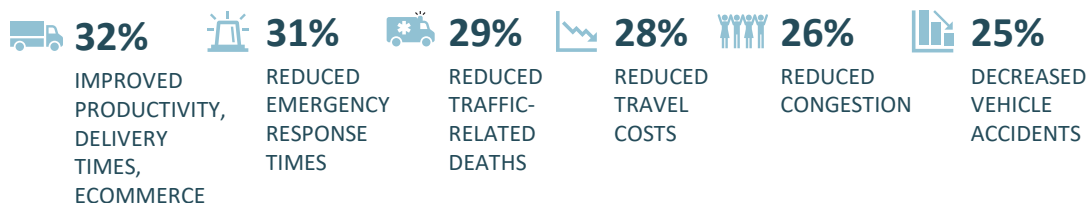
Digital solution	Digital public transit payment system		Real-time public transit app		Open loop payment system		Mobility-as-a-service app		Predictive maintenance	
	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders
ROI	4.0%	6.5%	3.6%	4.9%	3.5%	4.8%	2.8%	4.6%	1.6%	2.5%
Use	72%	76%	64%	88%	31%	60%	36%	52%	24%	32%



Traffic management

Smart initiatives for traffic management offer high returns for cities, particularly for leaders. Nearly all leaders (96%) have adopted real-time traffic management technologies, where they are seeing the strongest ROI—6.1%. They are unlocking more than four times the value that implementer cities are getting, at 1.5%, which makes the hyperconnectivity multiplier for real-time traffic management the highest among transportation investments. Private transportation initiatives offer both financial and quality of life benefits for cities.

Main benefits of traffic management initiatives



Digital solution	Curbside management		Public electric vehicle charging stations		Congestion charging		Real-time traffic management		Smart traffic signals		Smart parking apps	
	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders
ROI	4.7%	5.8%	4.3%	5.0%	4.3%	5.3%	4.0%	6.1%	3.3%	4.7%	2.9%	4.0%
Use	36%	68%	76%	92%	39%	68%	77%	96%	51%	72%	54%	60%



Water

Water-related projects offer both good returns and qualitative benefits. The most widely used technology is real-time water quality monitoring, which more than half of cities—and nearly all leaders—are using. Leaders are getting the highest returns from real-time usage monitoring, which only 43% of cities are currently using. One area that shows the full benefits of hyperconnectivity is predictive maintenance. The ROI for implementers is 0%, while for leaders it is 4%. Beyond ROI, water investments offer significant qualitative benefits as well—including improved public health—which accrue to all members of society.

Main benefits of water-related initiatives



Digital solution	Real-time water quality monitoring system		Real-time usage monitoring system		Water consumption tracking for users		Smart water meters		Predictive maintenance of water and sewer lines	
	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders
ROI	3.9%	5.1%	3.9%	6.3%	3.2%	5.4%	2.9%	5.2%	1.8%	4.0%
Using	52%	96%	43%	68%	28%	52%	62%	72%	24%	36%



Waste collection and the environment

Cities at all maturity levels are adopting smart waste collection and environmental technologies at a much lower rate compared with other areas of the urban ecosystem. But cities may want to turn their attention to these projects, since many of them generate large ROIs for leaders. For example, digital waste tracking has an average ROI of 6.8% for leaders, but only 44% of them—and 37% of all cities—are using it. Real-time air quality monitoring offers an even higher ROI for the 60% of leaders who use it, only 40% of all cities do so. In addition, waste management and environmental projects offer a range of other benefits, including improved health and reduced litter—which contribute to a city’s reputation and quality of life.

Main benefits of waste and environmental initiatives



Digital solution	Waste collection route optimization		Sensor enabled garbage bins		Digital waste tracking and payment		Recycling gamification		Real-time air quality monitoring	
	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders
ROI	4.1%	6.0%	4.0%	5.4%	3.8%	6.8%	2.0%	2.8%	4.1%	7.0%
Use	47%	68%	23%	44%	37%	44%	29%	44%	40%	60%



Energy and electricity

Dynamic electricity pricing offers the highest ROI among energy technologies. Leaders, which get higher returns, have been quick to adopt it. The most common initiatives are smart electricity meters and smart streetlights, which also offer strong returns. Smart electricity grids also have the potential to generate large returns for leaders, but cities have been slow to adopt them. The investment case for other energy investments is less clear. Smart streetlights can help cities save money through lower electricity costs and reduced maintenance spending. They also provide a platform for cities to deploy various sensor technologies. Nearly 70% of cities that have deployed smart streetlights have incorporated video surveillance, 58% traffic monitoring technologies, and 54% Wi-Fi hotspots.

Main benefits of energy and electricity initiatives



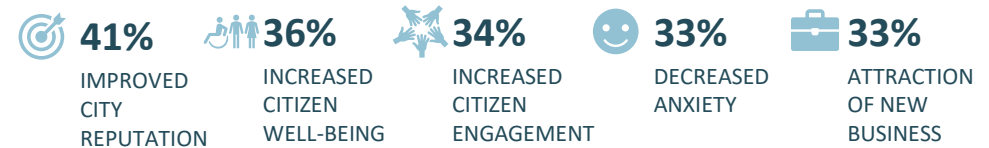
Digital solution	Dynamic electricity pricing		Smart streetlights		Smart electricity meters		Smart electricity grid		Microgrids		Gamified energy reduction program		Energy consumption tracking for users	
	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders
ROI	4.8%	5.7%	3.5%	4.7%	2.8%	4.9%	2.5%	4.5%	2.1%	2.1%	1.8%	2.5%	1.7%	2.2%
Use	47%	80%	59%	88%	64%	80%	35%	44%	25%	44%	17%	40%	31%	48%



Public safety

Even though some public safety technologies generate high returns, adoption rates remain relatively low. That is because crime is not a major problem for all cities; however, those that do adopt these technologies find substantial quality of life benefits. The technologies in greatest use are smart stations/kiosks that allow emergency calls, emergency notification apps, smart surveillance, and police body cameras. The highest ROI, however, comes from such less-used technologies as gun shot detectors and real-time crime mapping. Many leaders are making use of smart surveillance (72%) and facial recognition (68%).

Main benefits of public safety initiatives



Digital solution	Gun shot detectors		Real time crime mapping		Crowd sources crime reporting		Emergency notification apps	
	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders
ROI	6.1%	7.3%	4.7%	7.3%	4.5%	5.5%	3.8%	5.9%
Use	9%	20%	34%	48%	28%	36%	57%	80%

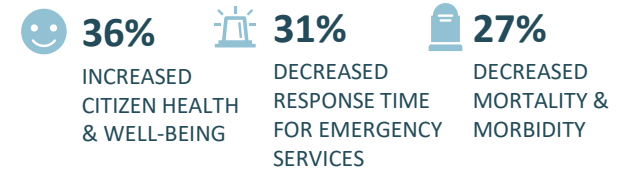
Digital solution	Smart stations (kiosks)		Body cameras for police		Facial recognition software		Smart surveillance	
	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders
ROI	4.0%	5.8%	2.3%	3.0%	1.9%	3.1%	1.9%	3.0%
Use	63%	80%	50%	60%	45%	68%	59%	72%



Public health

Public health and well-being initiatives not only drive quality of life but can also generate significant ROI for cities. First aid alerts provide the largest returns, overall. However their adoption rates remain low—only about a third of all cities use them. Remote patient monitoring, which is more common, results in high returns: 6.5% for leaders and 4.3% for all cities. Regardless of ROI, the lifesaving benefits of many other projects should make them a priority for cities.

Main benefits of health initiatives

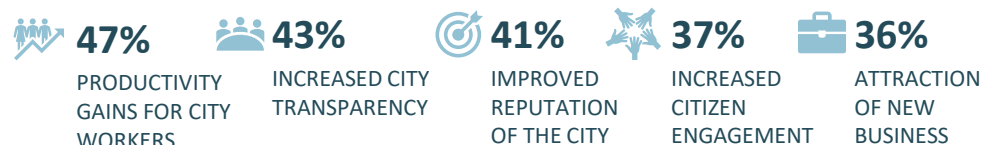


Digital solution	First aid alerts		Infectious disease surveillance		Remote patient monitoring		Emergency route optimization		Data-based public health interventions		Real-time air-quality monitoring apps	
	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders
ROI	5.6%	6.6%	4.4%	5.8%	4.3%	6.5%	3.5%	4.9%	3.5%	4.5%	3.1%	5.9%
Use	35%	56%	21%	40%	60%	88%	43%	56%	37%	68%	29%	68%

eGovernance

Digitalized systems lead to more productive city workers. The lion's share of cities have adopted digital payments and are seeing average returns of 4.7%. Although digital tax filings have the potential to generate greater ROI than digital payments, cities have been slower to adopt this solution. These innovations—which reduce paper and streamline processes—lead to productivity gains for workers and other benefits, such as increased transparency and improved city reputation.

Main benefits of eGovernance and e-payments



Digital solution	Digital tax filing		Digital licensing		Digital payments		Distributed government		Digitalized citizen services		"Just-in-time" civil services	
	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders	Total	Leaders
ROI	5.2%	7.1%	5.1%	6.6%	4.7%	6.0%	4.5%	4.6%	4.1%	5.2%	3.9%	6.2%
Use	63%	84%	44%	64%	85%	92%	37%	68%	63%	76%	44%	68%



Conclusion and case studies



New challenges and opportunities will keep emerging. In a digital world, innovation can keep pace with these changes. Unlike previous development models, where new systems were meant to last almost unchanged for a long length of time, the hyperconnected city requires that we think of innovation on a continuous basis.

**Suparno Banerjee, Global Public Sector Lead,
Enterprise, Nokia**



Conclusion

As we enter the Fourth Industrial Revolution, becoming a smart city is no longer enough. To unlock the full economic, social, environmental, and business value from technology, cities need to morph into hyperconnected urban centers.

Such cities use the latest technologies to transform and interconnect key areas of their ecosystem—from roads to cars, buildings to energy grids, and street lighting to police departments. Equally important, they interlink and engage government, business, academia, and people, and even other cities. By aligning urban assets and players, city leaders can fuel a virtuous cycle of economic, business, and social gains.

The hyperconnected multiplier effect

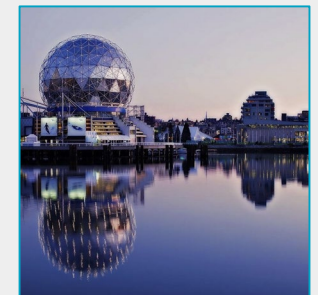
According to our study, the average return on investments in hyperconnected initiatives ranges from 3% to 4%. As cities become more interlinked, their ROI grows: cities just starting out realize a lower return than those further along. Implementers see a return of 1.8%, while advancers gain 2.6% and hyperconnected leaders get a 5% boost.

These percentages can translate into huge dollar amounts. The average city can unlock \$45 million in returns—which range from \$19.6 million for implementers to \$40 million for advancers and \$83 million for hyperconnected leaders. This is on top of the sizable social, quality of life, health, and environmental benefits. Technavio estimates that the worldwide market for smart city project investment is \$1.2 trillion, so if all cities move to become hyperconnected, they could generate a return of \$40 billion, with the impact

increasing to as high as \$60 billion if all cities were to become hyperconnected leaders.

Achieving these results requires a clear roadmap based on seven best practices followed by hyperconnected leaders in our study:

1. **Make the business case**, and continuously monitor performance, analyzing ROI systematically with the right metrics.
2. **Calculate the full benefits** to your city, including societal, business, economic, and environmental benefits.
3. **Organize your resources**, with a largely centralized department, and use both internal and external staff to operate your hyperconnected city programs.
4. **Capitalize on advanced technologies**—particularly various forms of AI—but bear in mind the importance of cybersecurity.
5. **Use the ecosystem effectively**, partnering with business and academia, but keeping crucial development and implementation tasks in-house.
6. **Generate more value from data** by gathering, integrating, and monetizing it, but in a responsible way, and sharing it with stakeholders as appropriate.
7. **Ensure all citizens are engaged and connected**, seeking input from stakeholders, and reaching out to disadvantaged populations.



Conclusion (continued)

Vaulting the hurdles

Even with this guidance in mind, there are roadblocks to avoid. Backlash from citizens and other stakeholders who feel their health, privacy, or other interests will be compromised by new technologies is one of the thorniest. Cities like Moscow, Barcelona, and Stockholm are working to alleviate this pushback by effective communication and outreach to build trust and engagement.

Cities must also overcome policy and regulatory barriers—particularly those around procurement—to get where they are going. Revising outdated city policies and working with regulators and higher levels of government to adapt laws and rules to the modern age are essential.

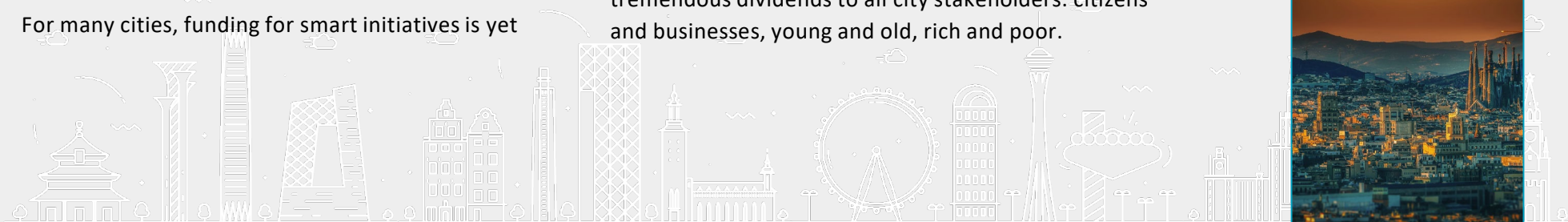
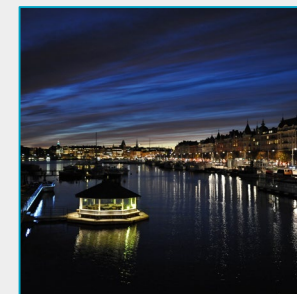
Keeping pace with technological change is always difficult; but doing so while maintaining cybersecurity and data privacy is a huge challenge even for the most advanced cities. While investing in cybersecurity may be a strain on city budgets, the costs of not doing so can be even larger as losses mount into the millions.

For many cities, funding for smart initiatives is yet

another hurdle, but there are many possible solutions, both public and private, that leaders around the world have adopted. While it's important to make a business case and calculate ROI to make their funding choices work for them, our research shows that cities don't always do the best job with this and often leave money on the table.

Many of the initiatives across the urban ecosystem with the highest ROI for leaders are not those with the highest rates of adoption. Examples include curbside management, real-time water usage monitoring, digital waste tracking, gunshot detection, and real-time crime mapping. Our analysis found that when it comes to getting the most ROI, city governments should look to themselves: reforming their own functions can have a big payback that many are not getting. Digital licensing and “just-in-time” civil services, for example, are two initiatives with high returns that only a minority of cities have adopted.

Getting past these roadblocks may not be easy, but the route to hyperconnectivity will provide tremendous dividends to all city stakeholders: citizens and businesses, young and old, rich and poor.



Hyperconnected cities case studies

To learn more, click or tap a case study below

Connected Citizens: How Moscow engages citizens through smart technologies
Interview: Eldar Tuzmukhametov, Head of Smart City Lab Smart Moscow

Mobility as a Service: Rides on a WHIM in Helsinki
Interview: Krista Hutala-Jenks, Head of Go-to-Market MaaS Global, Helsinki

Learning from Las Vegas: An innovative approach to partnering through pilots
Interview: Michael Sherwood, Chief Information Officer, City of Las Vegas

Achieving Efficiencies through PropTech
Interview: Nikki Greenberg, Head, Women in PropTech

Kista Science City, Stockholm: Engaging with the public to test new ideas
Interview: Petra Dalunde, Chief Operating Officer, Urban ICT Arena

Hyperconnected Streetlights: Georgia Power is expanding the state's smart LED lighting network
Interview: Justin Harmond, Assistant to EVP, Georgia Power

Citizens as Customers in Tel Aviv
Interview: Zohar Sharon, Chief Knowledge Officer, Tel Aviv

Santiago of Tomorrow: Finding innovative solutions in emerging markets
Interview: Gloria Moya, Deputy Regional Director, Corporation for Production Development (Corfo)



Appendix



The concept of the smart city has been around for years and while the vision and promise of smart cities resonates for many, there is no one blueprint that meets every city's unique DNA. Each city's plan and approach will be different based on the specific characteristics of its community. So, the foundation of any planning should be a clear understanding of your city's needs and a vision for its future.

Wayne Best, Chief Economist, Visa



100 Hyperconnected Cities

We conducted detailed benchmarking surveys on 100 hyperconnected cities located in 52 countries across all world regions. The 100 cities were drawn from a list of 171 cities that were identified as hyperconnected cities. To be included on the list, a city had to appear in at least one of the secondary sources and/or be a suggestion from a sponsor or research partner.

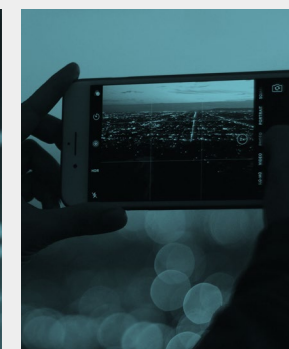


Constructing the Hyperconnected City Index

To create the Hyperconnected Cities Index, we looked at four pillars supporting city transformation:

- Technology
- Data and analytics
- Cybersecurity
- Citizen connectivity and engagement

To underpin each pillar, we used data from several survey questions, calculating a score for each, normalizing and combining them to arrive at a pillar score. We then aggregated the pillar scores into an overall index score.



The hyperconnected city index



TECHNOLOGY



DATA & ANALYTICS



CYBERSECURITY



CONNECTED CITIZENS



Pillar 1 Technology

The **technology pillar** examines the digital technologies that cities use, and how and where they use them.

The pillar is based on the following questions:

Q19 - Which of the following digital technologies does your city actively use to support its operations?

The number of areas where the following technologies are used:

- AI
- Biometrics
- Cloud
- IoT
- Percent of the city covered in Wi-Fi

Q20 - Do you agree or disagree with the following statements relating to your city's approach to technology use and digital innovation?



TOP 20 CITIES *Technology*

- 1 Singapore
- 2 Seoul
- 3 Melbourne
- 4 Copenhagen
- 5 Hong Kong
- 6 Houston
- 7 Delhi
- 8 Chicago
- 9 Madrid
- 10 Beijing
- 11 Shenzhen
- 12 Rome
- 13 Sydney
- 14 Philadelphia
- 15 Dallas
- 16 Washington
- 17 Istanbul
- 18 Baltimore
- 19 Nashville
- 20 Brisbane





Pillar 2 Data and analytics

The **data and analytics pillar** evaluates a city's approach to gathering, using, and managing data, the types of data used, and where the city is using data to drive results. The pillar is based on the following questions:

Q15 - Do you agree or disagree with the following statements relating to your city's approach to data gathering and management?

Q16 - Which of the following types of data is your city actively using now to drive smart city initiatives?

Q17 - Please tell us your city's maturity stage in the use of data and data analytics in the following areas today.

Q18 - In which areas is your city using advanced data and analytics to gain insights and improve performance?



TOP 20 CITIES *Data & Analytics*

- 1 Singapore
- 2 Seoul
- 3 Hong Kong
- 4 Beijing
- 5 Melbourne
- 6T Houston
- 6T Shenzhen
- 8 Istanbul
- 9 Sydney
- 10 Moscow
- 11 Delhi
- 12 Cambridge
- 13 Rome
- 14 Dublin
- 15 Shanghai
- 16 New York
- 17 Madrid
- 18 London
- 19 Tel Aviv
- 20 Copenhagen



Pillar 3 Cybersecurity

The **cybersecurity pillar** assesses how prepared cities are for cybersecurity attacks and the risk mitigation steps they are taking. The pillar is based on the following questions:

Q50 - Overall, how well prepared is your city for cyberattacks?

Q54 - What progress have you made in each of the following cybersecurity activities and what progress do you expect to make over the next three years?

- Identify vulnerabilities and risks
- Protect against cyber-risks
- Detect cyberattacks
- Respond to cyberattacks
- Recover from cyberattacks



TOP 20 CITIES *Cybersecurity*

- 1 Seoul
- 2 Rome
- 3 Singapore
- 4 Copenhagen
- 5T Melbourne
- 5T Shenzhen
- 7T Ottawa
- 7T Tel Aviv
- 7T Beijing
- 7T Hong Kong
- 11 Chongqing
- 12T Cambridge
- 12T Houston
- 14T Detroit
- 14T Shanghai
- 16 Dublin
- 17T Istanbul
- 17T Delhi
- 19 Madrid
- 20 Charlotte





Pillar 4 Connected citizens

The **connected citizen pillar** measures how well cities engage with their key stakeholders and the methods they use to communicate and interact.

The pillar is based on the following questions:

Q8 - Which of the following methods do you use now for citizen engagement?

Q9 - Do you agree or disagree with the following statements relating to your city's approach to citizen engagement?

Q10 - Does your city have a Chief Citizen Experience Officer (CCXO), Chief Citizen Officer (CCO), or similar individual who is responsible for citizen engagement?

Q11 - How familiar are each of the following groups with your city's smart city activities?



TOP 20 CITIES *Connected Citizens*

- 1 Singapore
- 2 Detroit
- 3 Sydney
- 4 Melbourne
- 5 New York
- 6 Houston
- 7 London
- 8 Brisbane
- 9 Seoul
- 10 Chicago
- 11 Hong Kong
- 12 Berlin
- 13 Dublin
- 14 Ottawa
- 15 Washington
- 16 Rome
- 17 Madrid
- 18 Edmonton
- 19 Istanbul
- 20 Moscow





ESI ThoughtLab is an innovative thought leadership and economic research firm providing fresh ideas and evidence-based analysis to help business and government leaders cope with transformative change. We specialize in analyzing the impact of technological, economic, and demographic shifts on industries, cities, and companies.

ESI ThoughtLab is the thought leadership arm of Econsult Solutions, a leading economics consultancy with links to the academic community.

Building a #HyperconnectedCity

ESI ThoughtLab's Hyperconnected City Team

Lou Celi, Project and Editorial Director
Chief Executive Officer, ESI ThoughtLab
Lceli@esithoughtlab.com
(917) 459- 4614

Anna Szterenfeld, Project Editor
Director of Editorial Operations
Aszterenfeld@esithoughtlab.com
(201) 803-1789

Daniel Miles, Economic Director
Chief Economist, ESI ThoughtLab
Dmiles@esithoughtlab.com
(215) 717-2777

Steve Wray, Research Manager
Vice President Econsult Solutions
Swray@esithoughtlab.com
(215) 717-2777

Mike Daly, Marketing Manager
Communications Specialist, ESI ThoughtLab
Mdaly@esithoughtlab.com
(215) 717-2777

Caroline Lindholm, Project Coordinator
Research and Administrative Assistant, ESI ThoughtLab
Clindholm@esithoughtlab.com
(215) 717-2777

