ESI THOUGHTLAB

A leader in evidence-based research

Smarter Cities 2025

Building a sustainable business and financing plan

An interactive thought leadership report

November 2018

ADVANCE ▷

Introduction

This eBook presents our key findings, along with insights into best practices, performance metrics, and calls to action. It is presented as an interactive report to allow users to easily navigate to areas of interest. We hope you find it a useful tool for understanding the economics of smart cities and advancing your urban agenda.

"The cities of the future—and the cities of the present that will be relevant in the future—will be smart. Full of sensors, data, and analysis that help the traffic flow, civic leaders lead, and citizens fully realize all the benefits of working and living in their city."
- Ben Pring, Managing Director, Cognizant's Center for the Future of Work

A message from the program directors

In today's digital age, becoming a smart city is vital for attracting business, residents, tourists, and talent, and for ultimately fostering growth and prosperity. But the path to a smart city future is often unclear to urban leaders, who require a deeper grasp of the approaches that will drive the best results.

To provide cities with a more effective roadmap, ESI ThoughtLab teamed up with a coalition of organizations with urban and technology expertise to conduct ground-breaking research into the impact of smart city solutions on urban performance. Our analysis enabled us to answer three crucial questions facing today's local governments:

- What are the characteristics of successful smart cities, and how do they create value for residents, businesses, and local government?

- What is the most effective path to becoming a smart city, and how do you need to adjust it for your city's unique economic and social footprint?

- What are the quantifiable direct, indirect, and catalytic benefits of smart city investments? Which approaches will have the biggest impact on business growth, economic competitiveness, and living standards?

This e-book provides a comprehensive look at the smart city practices and performance results of 136 worldwide cities, with insights from 750 businesses and 2,000 citizens in 11 representative cities. We hope you find it a valuable tool for building your smart city future.

Louis Celi
Chief Executive Officer
ESI ThoughtLab

Daniel Miles, Ph.D.
Chief Economist
ESI ThoughtLab

Sponsors and research partners

Smarter Cities 2025 was sponsored by a coalition of leading consulting firms and providers of smart city services, platforms, and products. Each organization is an expert in its own field, and all of them would be happy to share their 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 invaluable insights and guidance throughout the research process. Their multidisciplinary perspectives ensured an insightful and balanced view of the issues that urban centers face as they strive to become smart cities.

We would like to thank our sponsors, research partners, and project management team for helping us create this watershed study.

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accenture consulting   CBRE   Cognizant

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Research partners

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SOGANG UNIVERSITY   Meeting of the Minds   Renaissance URBaiNe

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Smarter Cities 2025 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 **Smarter Cities 2025**.

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Research Methodology

ESI ThoughtLab's team of economists and thought leadership specialists led a multi-pronged research effort that produced rigorous benchmarking analysis of smart cities practices and performance results.

"Cities strive to innovate, but funding these initiatives—when ROI has been uncertain—has been challenging. Advanced technologies are the path, and cities need to develop a framework that will help them identify how to prioritize and measure their modernization efforts."

- Susan O'Connor, Global Director, Public Sector Industry Marketing, Oracle

Our rigorous analytical approach

To start the project, ESI ThoughtLab conducted in-depth benchmarking surveys of government leaders in 136 cities around the world to understand their smart city perspectives, practices, and performance results.

To gain insight into the views of city stakeholders, we also conducted surveys of 750 business leaders and 2,000 residents in 11 representative cities with varying levels of economic development, social and geographic diversity, and smart city "maturity".
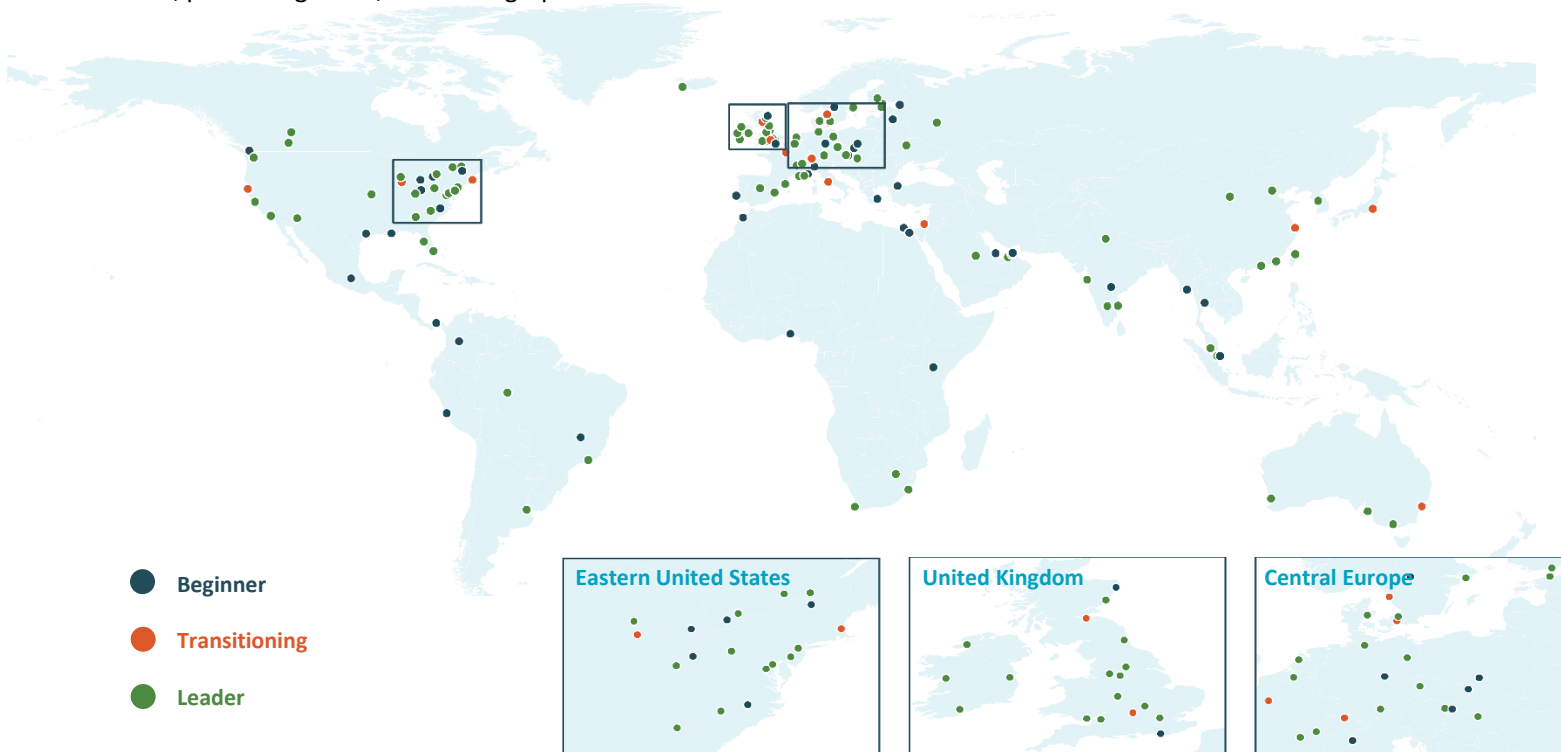
We then analyzed and correlated the statistical input from the governments, citizens, and businesses to understand the alignment in ways of thinking about smart cities. Drawing on the survey data and respected secondary sources, we then created micro- and macro-economic models to quantify the direct, indirect, and catalytic benefits of smart city investments in the 11 proxy cities, which could be extrapolated to cities with similar characteristics.

Throughout the research process, our distinguished advisory board of business and academic leaders provided valuable input on smart city practices and their impacts.

Benchmarking surveys of urban leaders in 136 cities

In-depth surveys of businesses and citizens in 11 proxy cities

Research input from global advisory board of experts

Micro- and macro-economic modeling

Benchmarking analysis on 136 cities around the world

We conducted benchmarking surveys on 136 cities located in 55 countries across all world regions. The cities ranged across various levels of economic development, from least developed to highly advanced. They also faced different urban challenges, such as high crime, poor infrastructure, pollution growth, and demographic shifts.


● **Beginner**

● **Transitioning**

● **Leader**

Eastern United States

United Kingdom

Central Europe

Profile of cities surveyed

The cities we surveyed range in size from 35,000 to over 37 million residents, and represent approximately 10% of the world's population. About one-third of the cities we surveyed are in emerging-market economies, while the other two-thirds are in more developed countries.

Africa	Asia Pacific	Eastern Europe	Middle East	North America	South America	Western Europe
7	22	10	8	33	7	49

Respondents by population size

48%

21%

18%

14%

< 1 million   1-5 million   5-10 million   > 10 million
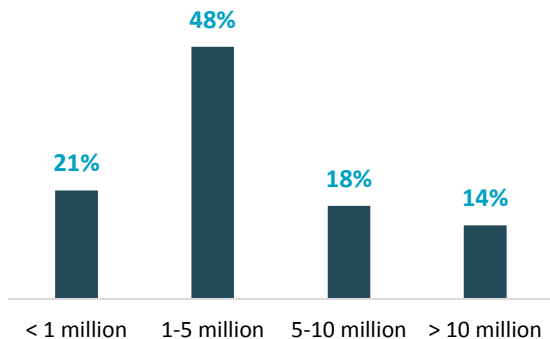
Respondents by country's level of development
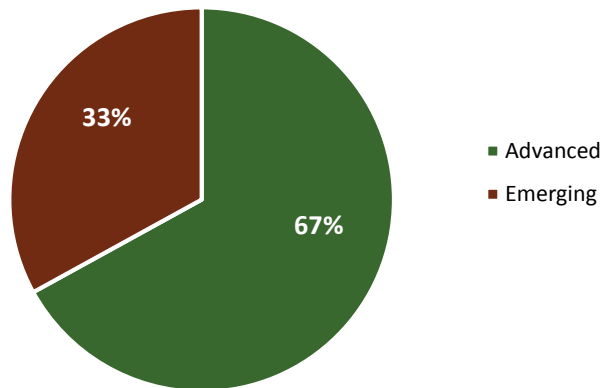
33%

67%

■ Advanced
■ Emerging

Government benchmarking survey

The 136-city survey was administered to key government officials, including those in mayoral offices, technology executives, COO/CFOs, and their direct reports. The majority were either chiefs of staff, city managers, or direct reports. About 5% of the respondents were directors of smart city initiatives and another 6.6% were directors of innovation.

The survey questioned them about priorities and progress in different areas of smart city development, as well as their concerns and challenges.

Government survey respondents by position
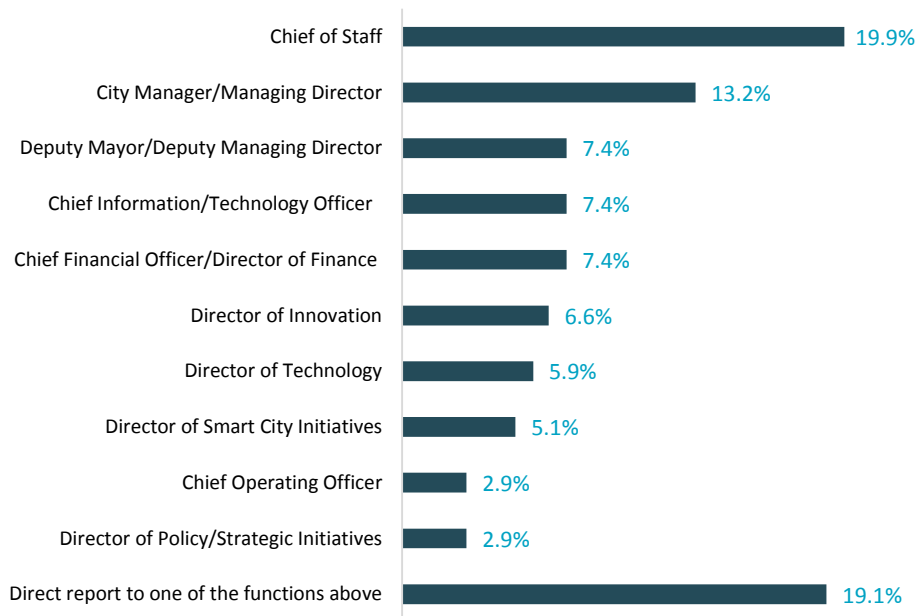
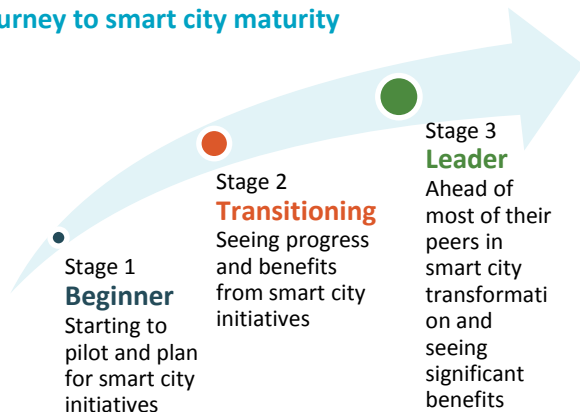| Position	Percentage
Chief of Staff	19.9%
City Manager/Managing Director	13.2%
Deputy Mayor/Deputy Managing Director	7.4%
Chief Information/Technology Officer	7.4%
Chief Financial Officer/Director of Finance	7.4%
Director of Innovation	6.6%
Director of Technology	5.9%
Director of Smart City Initiatives	5.1%
Chief Operating Officer	2.9%
Director of Policy/Strategic Initiatives	2.9%
Direct report to one of the functions above	19.1%

Defining smart city maturity

The future economic and social success of cities will be determined by their ability to evolve as smart cities. By drawing on the latest technologies and capitalizing on data analytics, smart cities will be better equipped to solve urban problems, provide high-quality services, and drive sustainable growth.

As part of our benchmarking analysis, we calculated a "smart city maturity score" for each of the 136 cities, based on responses to key questions in the government survey about each of the 10 smart city "pillars" that we identified. The score was divided into four equally weighted components:
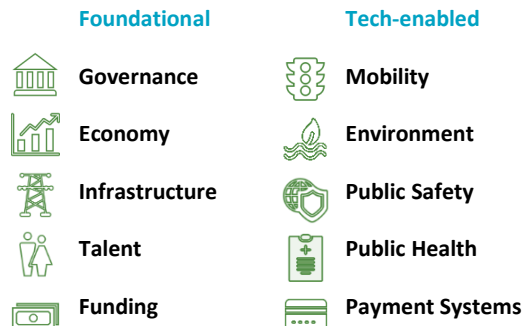
1. Level of smart city investments

2. Use of data analytics

3. Application of smart technologies

4. Self-rating on stage of smart city maturity

We arrived at an overall score by combining the normalized scores for each pillar. Based on the scores, we stratified the cities into three categories: **beginner**, **transitioning**, and **leader**. We designated 11 proxy cities across maturity stages that could serve as representative cities for our deep-dive analysis.

Journey to smart city maturity

Stage 1
Beginner
Starting to pilot and plan for smart city initiatives

Stage 2
Transitioning
Seeing progress and benefits from smart city initiatives

Stage 3
Leader
Ahead of most of their peers in smart city transformation and seeing significant benefits

Across 10 pillars of smart city success

Foundational	Tech-enabled
Governance	Mobility
Economy	Environment
Infrastructure	Public Safety
Talent	Public Health
Funding	Payment Systems

Cities by maturity classification

Beginner

Aberdeen	Jena
Alexandria	Kiev
Athens	Lagos
Bangkok	Lisbon
Bogota	Mexico City
Brantford	Milan
Bratislava	Monaco
Burlington	Nairobi
Cairo	New Orleans
Casablanca	Ostrava
Columbus	Panama City
Czestochowa	Rēzekne
Detroit	Saint Petersburg
Doha	Sharjah
Galway	Skövde
Greater Belo Horizonte	Tampines
Houston	Vancouver
Hyderabad	Yangon
Istanbul	

Transitioning

Aarhus	Charlotte	Leeds	Nice	Tallinn
Abu Dhabi	Chennai	Lima	Ottawa	Tampa
Adelaide	Cincinnati	Los Angeles	Perth	Tampere
Amsterdam	Cork	Lyon	Philadelphia	Toronto
Atlanta	County Donegal	Macau	Phoenix	Valencia
Baltimore	Dubai	Madrid	Pittsburgh	Washington, DC
Barcelona	Dublin	Manchester	Prague	
Beijing	Dundee	Marseille	Raleigh	
Bengaluru	Durban	Melbourne	Reykjavik	
Berlin	Edmonton	Miami	Rio de Janeiro	
Birmingham	Geneva	Milton Keynes	Riyadh	
Brighton and Hove	Hamburg	Milwaukee	San Jose	
Bristol	Helsingborg	Montreal	Sao Paulo	
Brussels	Helsinki	Moscow	Seattle	
Budapest	Hong Kong	Mumbai	Seoul	
Buenos Aires	Johannesburg	Munich	Sheffield	
Calgary	Kansas	New Delhi	Singapore	
Cape Town	Karachi	New York	Stockholm	
Cardiff	Kuala Lumpur	Newcastle upon Tyne	Taipei	

Leader

Boston	San Francisco
Chicago	Shanghai
Copenhagen	Sydney
Edinburgh	Tel Aviv
Gothenburg	Tokyo
London	Vienna
Oxford	Yinchuan
Paris	Zurich
Rome	

Identifying 11 proxy cities

ESI ThoughtLab worked together with our advisory board to identify 11 proxy cities across each maturity stage that represented different levels of economic development, population size, and geographic location. To gain insight into smart city perspectives from urban stakeholders, we also conducted in-depth surveys of businesses and citizens in each of these cities. We then extrapolated our analysis of these proxy cities to other similar urban areas.
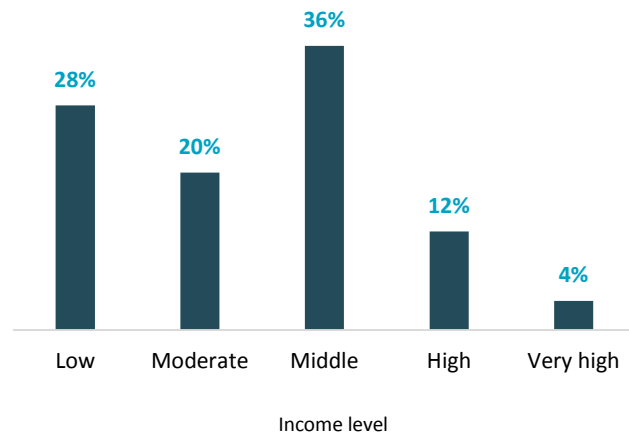
Copenhagen

Moscow

Chicago

Madrid

Athens

Tokyo

Dubai

Shanghai

New Delhi

Lagos

Beginner

Greater Belo Horizonte

Transitioning
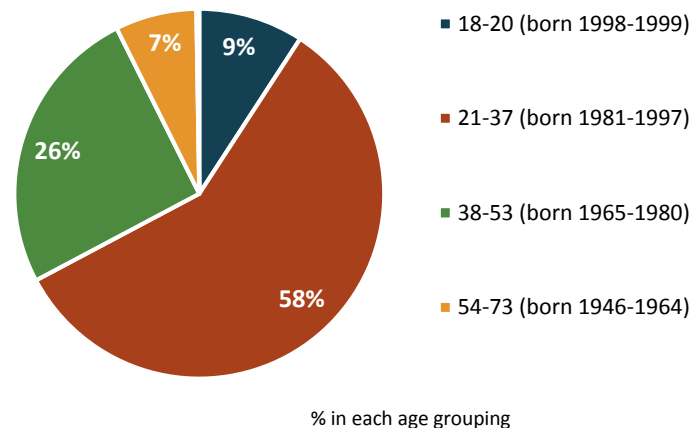
Leader

Profile of citizens surveyed

To gather local resident views on smart city initiatives and benefits, ESI ThoughtLab surveyed approximately 180 citizens in each of 11 proxy cities, for a total of 2,000 residents. The survey included a diverse mix of individuals by age and income levels.

Chicago	Copenhagen	Shanghai	Tokyo	Dubai	Madrid	Moscow	New Delhi	Athens	Greater Belo Horizonte	Lagos
187	172	185	185	180	180	186	185	180	180	180

Income level of respondents

- Low — 28%
- Moderate — 20%
- Middle — 36%
- High — 12%
- Very high — 4%

Income level

Age of respondents

- 18-20 (born 1998-1999) — 9%
- 21-37 (born 1981-1997) — 58%
- 38-53 (born 1965-1980) — 26%
- 54-73 (born 1946-1964) — 7%

% in each age grouping
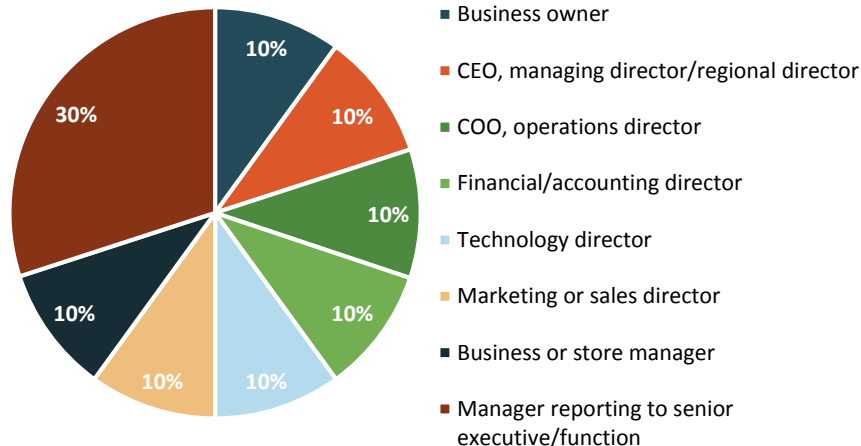
Profile of businesses surveyed

ESI ThoughtLab surveyed business leaders to gain their insights into their city's progress on smart initiatives, future trends, and perceived benefits. We surveyed 65-70 businesses in 11 proxy cities, for a total of 750 organizations. Survey respondents included a diverse mix of companies by size, industry, and executive function.

Chicago	Copenhagen	Shanghai	Tokyo	Dubai	Madrid	Moscow	New Delhi	Athens	Greater Belo Horizonte	Lagos
70	65	70	70	70	70	70	70	65	65	65

Business survey respondents by size
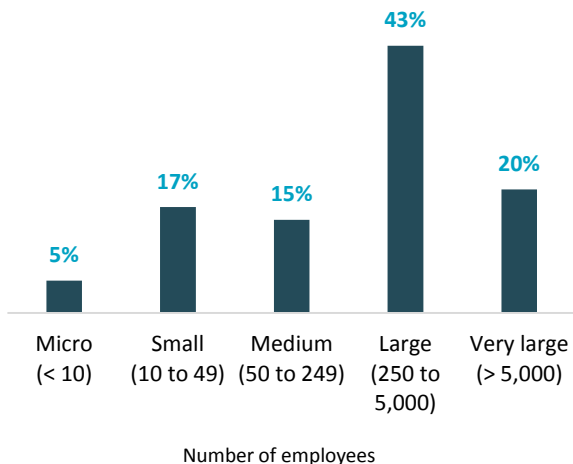
Business survey respondents by title

- Business owner
- CEO, managing director/regional director
- COO, operations director
- Financial/accounting director
- Technology director
- Marketing or sales director
- Business or store manager
- Manager reporting to senior executive/function

Smart city performance impact modeling

ESI ThoughtLab economists created rigorous performance impact models for five key "pillars" of smart city development: mobility, environment, public safety, public health, and payment systems.

The economic models draw on the following data:

1. Secondary data on the impacts of smart city investments.

2. City-specific government survey data on smart city practices.

3. City-level profile data (e.g. on population, income, transit ridership).

4. Primary data from the business and consumer surveys.

Using that data, ESI ThoughtLab also modeled the catalytic economic impacts of smart city initiatives using the National Institute of Economic and Social Research's highly respected global econometric model.

By measuring the direct, indirect, and catalytic benefits of smart city programs, our models allow us to estimate the impacts if each city were to become a smart city leader. By benchmarking cities according to their stages of smart city maturity, our economists are able to extrapolate the potential performance impact for other cities in similar stages of development.
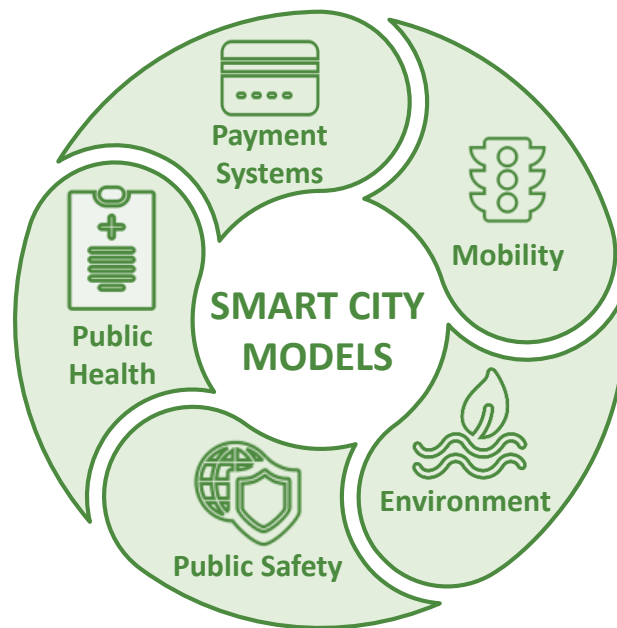
SMART CITY MODELS — Payment Systems, Mobility, Environment, Public Safety, Public Health

The Path to a Smart City Future

"Ensuring your city has a digital strategy in place is key for a successful transformation. To be effective, city leaders need to ask if their digital city strategy is design-driven, value-led, politically endorsed, and if it delivers a viable ecosystem."

- Jen Hawes-Hewitt, Global Cities Lead, Accenture

Cities need to build a clear path to smart city transformation

The convergence of digitization, globalization, and demographic change is redefining the urban landscape and how people shop, work, travel and live. Businesses with a stake in the future of cities are fast developing innovative solutions to meet the new realities of urban life and digital commerce.

By making their cities smarter—not just in using technology but in all that they do—government leaders hope to drive competitiveness and growth, while making massive social, business and environmental improvements.

But without a clear playbook for the future, cities run the risk of falling behind their peers. The path will vary by city—depending on the issues it faces. The key challenge for urban leaders is incorporating the concerns of their stakeholders into a properly staged roadmap that will lead to the best results.

Roadmap for smarter cities

1 Assess stakeholder concerns
Ensure alignment with stakeholders' priorities and give them input to gain their buy-in.

2 Remove obstacles
Cities are often held back due to political challenges, cybersecurity worries, inertia, or uncertain ROI.

3 Fully leverage data
Make sure you are gathering, analyzing, and integrating a wide array of data and making it accessible to stakeholders.

6 Don't make cybersecurity an afterthought
Most cities, especially smart city beginners, are not well prepared for cyberattacks. As cities become *smarter,* their risks multiply.

5 Keep pace with digital innovation
Make sure you don't fall behind on core technologies, like cloud, biometrics, and mobile apps, or emerging ones, such as AI, IoT, smart beacons, and chatbots.

4 Lay the IT groundwork
Install the broadband, shared architecture, and scalable systems, as well as the processes and standards, needed to support smart initiatives.

7 Draw on digital ecosystems
Cities can partner with technology providers and universities or outsource development and implementation.

8 Invest wisely
Benchmarked cities are allocating about 15% of their operating budgets and 17% of their capital budget to smart city programs.

Assess stakeholder concerns to set goals

A key to building a clear roadmap for smart city transformation is fully understanding common priorities and concerns, and key differences among urban stakeholders.

While city businesses and citizens have different perspectives on the problems facing cities, climate change and mobility/congestion are near the top of the list for most stakeholders. That may help explain both the expectations for future development of mobility and environmental applications, and the willingness of both citizens and businesses to pay more for those investments.

Government	Citizens	Businesses
Energy and the environment	Jobs and opportunities	Housing and office space
Mobility/congestion	Crime/public safety	Driving economic development
Climate change	Economic challenges	Financial inclusiveness
Livability/citizen happiness	Affordability	Business attraction
Public health	**Climate change**	**Mobility/congestion**
Economic development	Budget deficits	Economic challenges
Changing demographics/diversity	**Mobility/congestion**	Crime/public safety
Inadequate/obsolete infrastructure	Public health	**Climate change**
Urban influx/population growth	Education and talent gaps	Budget deficits

Q: Please indicate the main challenges that your city is addressing or planning to address through smart city initiatives.

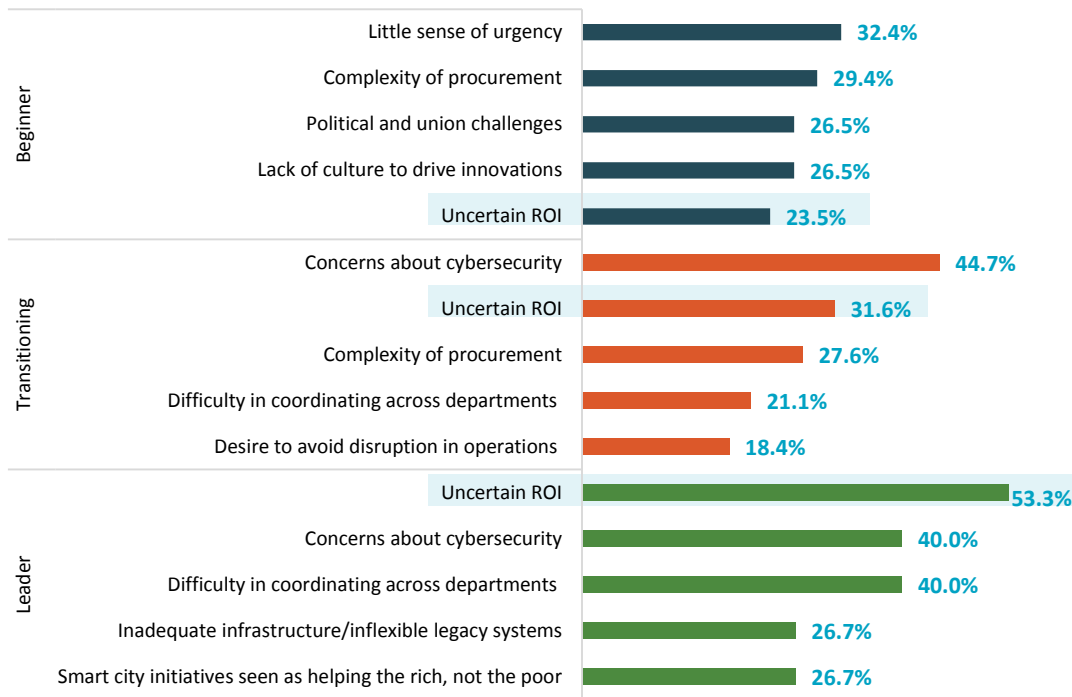# Keep in mind the potential obstacles

When starting their smart journey, cities often are held back because of inertia and political, union, and cultural challenges.

As cities mature, cybersecurity, departmental coordination, and operational disruption rise as worries.

While some of these obstacles remain for leaders, concerns over legacy systems and inclusivity grow.

Uncertain ROI is a hurdle for all cities, regardless of maturity.

Q: Please rate the following obstacles that your city faces when implementing smart city plans.

Obstacles to digital maturity by smart city maturity level

Beginner
- Little sense of urgency — **32.4%**
- Complexity of procurement — **29.4%**
- Political and union challenges — **26.5%**
- Lack of culture to drive innovations — **26.5%**
- Uncertain ROI — **23.5%**

Transitioning
- Concerns about cybersecurity — **44.7%**
- Uncertain ROI — **31.6%**
- Complexity of procurement — **27.6%**
- Difficulty in coordinating across departments — **21.1%**
- Desire to avoid disruption in operations — **18.4%**

Leader
- Uncertain ROI — **53.3%**
- Concerns about cybersecurity — **40.0%**
- Difficulty in coordinating across departments — **40.0%**
- Inadequate infrastructure/inflexible legacy systems — **26.7%**
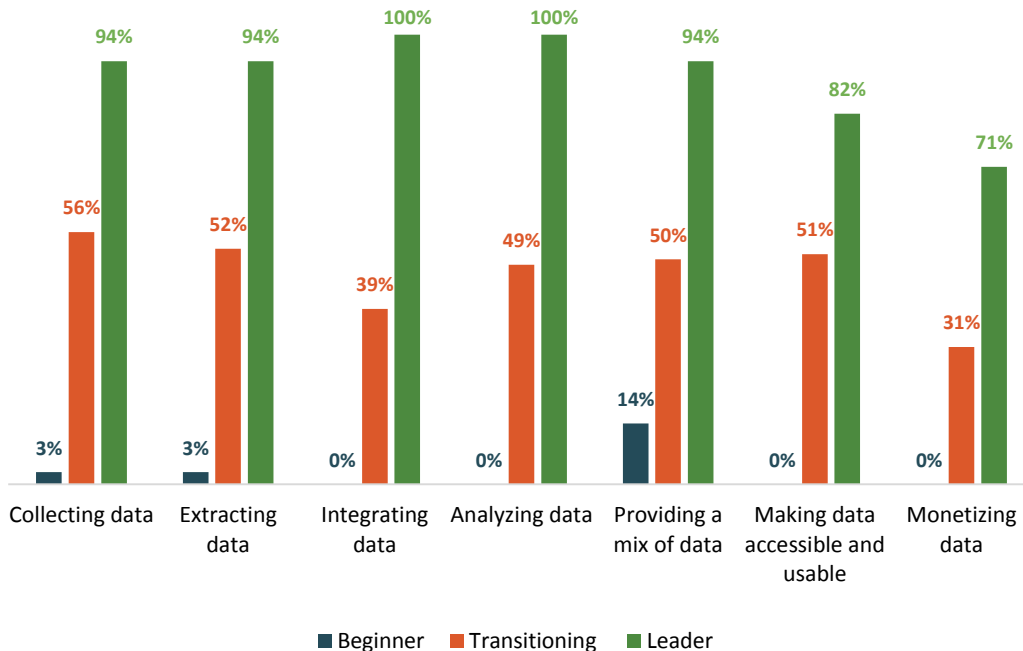- Smart city initiatives seen as helping the rich, not the poor — **26.7%**

Data is the rocket fuel for smart city transformation

Smart cities run on data. Yet few beginning cities are doing even basic data tasks, such as collecting, extracting, integrating, and analyzing data. Transitioning cities are far more advanced in their use of data compared with beginning cities. Even so, they are still at only half the level of the leaders.

The vast majority of leaders excel at collecting, extracting, integrating, analyzing, and providing a mix of data. More than two-thirds are also skilled in more sophisticated data uses, such as making data accessible to stakeholders and monetizing its value. Since many smart solutions, from mobility to public safety, are dependent on data, it is vital for cities to make data management an area of excellence.

Q: Please tell us your city's stage of development in the use of data and data analytics in the following areas.

Level of data maturity by smart city maturity

Chart data by category (Beginner, Transitioning, Leader):
- Collecting data: 3%, 56%, 94%
- Extracting data: 3%, 52%, 94%
- Integrating data: 0%, 39%, 100%
- Analyzing data: 0%, 49%, 100%
- Providing a mix of data: 14%, 50%, 94%
- Making data accessible and usable: 0%, 51%, 82%
- Monetizing data: 0%, 31%, 71%

Legend: ■ Beginner ■ Transitioning ■ Leader

Cities plan to amplify their use of a rich array of data

Over the next three years, cities across smart city maturity levels plan to rachet up their use of a wider variety of data.

By 2021, almost all cities will draw on IoT and real-time data. Geospatial, administrative, behavioral, predictive, and social media data will become commonplace.

The use of AI-generated data will grow fourfold. Predictive data, which is already used by about 40% of cities, will rise in usage by 63%. Similarly, both geospatial and behavioral data will rise by 54%.

While the gap in data use will close considerably between cities in the three stages of smart city maturity, leaders will remain far out front of others in their use of AI-generated data.

Q: Which of the following types of data is your city currently using to drive smart city initiatives, and which do you plan to use over the next three years?

Growth in use of types of data over the next three years

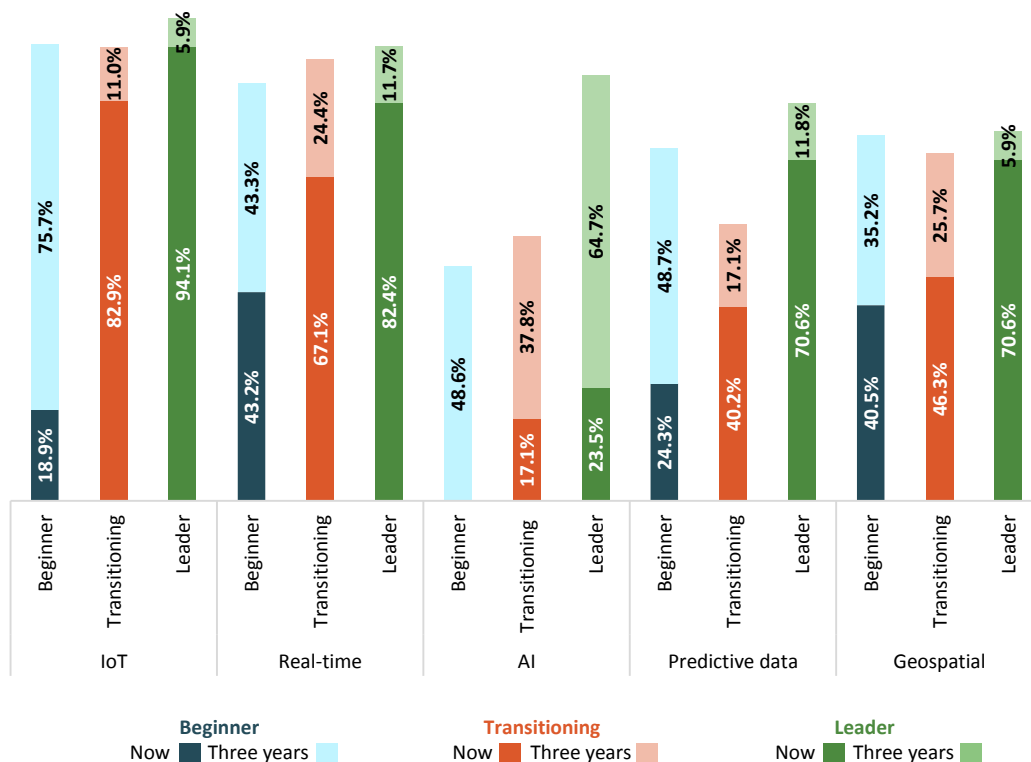| Technology	Now	3 years	Increase
Internet of Things	67%	95%	+42%
Real-time	63%	90%	+45%
Administrative	60%	70%	+17%
Local business	50%	58%	+16%
Social media	49%	64%	+32%
Geospatial	48%	74%	+54%
Behavioral	45%	69%	+54%
Channel use	42%	56%	+33%
Predictive data	40%	65%	+63%
Crowd-sourced	34%	49%	+43%
Psychographic	31%	46%	+48%
Artificial intelligence	13%	58%	+336%

Follow the leaders

Cities identified as smart city leaders are now far ahead of others in the use of emerging sources of data, such as IoT, real-time, AI, predictive, and geospatial data. By 2021, most leaders will use these more sophisticated forms of data.

Beginners have made less progress: fewer than 1 out of 4 now use IoT or predictive data, and only about 4 out of 10 currently draw on real-time or geospatial data.

Over the next three years, beginners and intermediate cities hope to catch up to the leaders in their use of emerging technologies. But keeping up on the use of AI and data will likely elude them.

Q: Which types of data is your city currently using to drive smart city initiatives now, and which do you believe you will be using within the next three years?

Use of emerging sources of data over the next three years

Bar chart data:

IoT
- Beginner: Now 18.9%, Three years 75.7%
- Transitioning: Now 82.9%, Three years 11.0%
- Leader: Now 94.1%, Three years 5.9%

Real-time
- Beginner: Now 43.2%, Three years 43.3%
- Transitioning: Now 67.1%, Three years 24.4%
- Leader: Now 82.4%, Three years 11.7%

AI
- Beginner: Three years 48.6%
- Transitioning: Now 17.1%, Three years 37.8%
- Leader: Now 23.5%, Three years 64.7%

Predictive data
- Beginner: Now 24.3%, Three years 48.7%
- Transitioning: Now 40.2%, Three years 17.1%
- Leader: Now 70.6%, Three years 11.8%

Geospatial
- Beginner: Now 40.5%, Three years 35.2%
- Transitioning: Now 46.3%, Three years 25.7%
- Leader: Now 70.6%, Three years 5.9%

Legend:
- **Beginner** — Now (dark), Three years (light blue)
- **Transitioning** — Now (orange), Three years (light orange)
- **Leader** — Now (dark green), Three years (light green)

Laying sound IT groundwork is a prerequisite for smart city success

Most smart city technologies run on sensors and other connected assets that are linked together through wireless and broadband networks.

Becoming a smarter city is a journey, not a destination, which requires continual digital transformation to keep up with the evolving practices of businesses and consumers.

Few beginning cities have the IT infrastructure in place to support effective smart city transformation. They lack the broadband systems, digital transformation processes, shared architecture, scalable systems, and other elements needed to move up the smart city maturity curve.

Q: Which of the following best describes your city's use of technology?

% of cities that are advanced in the use of various technologies and solutions (by stage of smart city maturity)
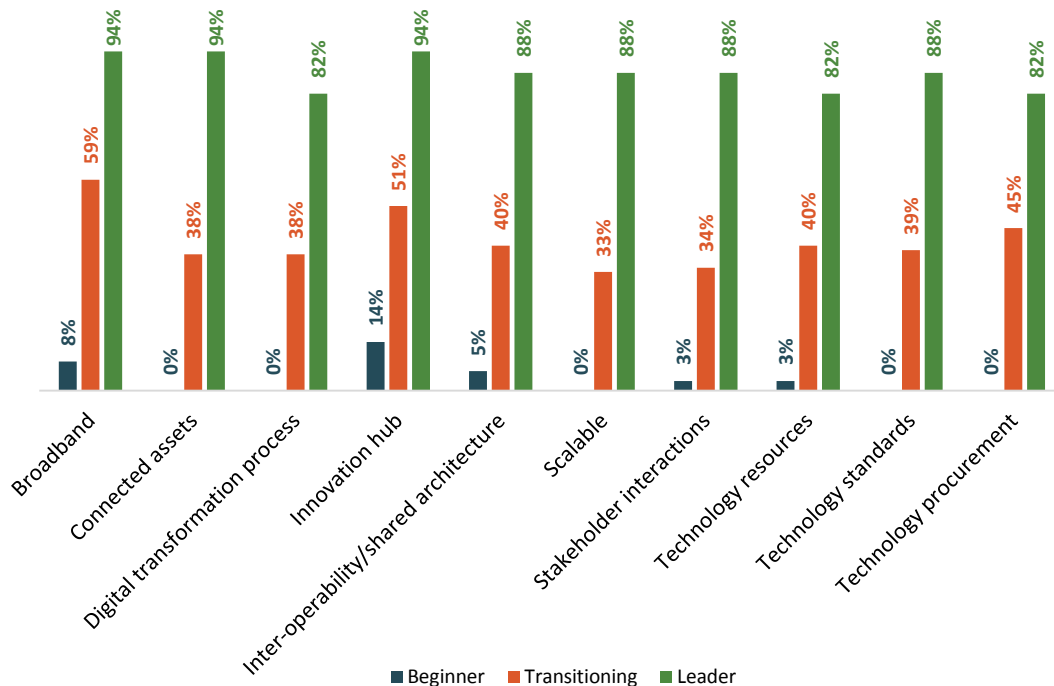
Technology	Beginner	Transitioning	Leader
Broadband	8%	59%	94%
Connected assets	0%	38%	94%
Digital transformation process	0%	38%	82%
Innovation hub	14%	51%	94%
Inter-operability/shared architecture	5%	40%	88%
Scalable	0%	33%	88%
Stakeholder interactions	3%	34%	88%
Technology resources	3%	40%	82%
Technology standards	0%	39%	88%
Technology procurement	0%	45%	82%

■ Beginner ■ Transitioning ■ Leader

Harnessing smart technologies

Cloud-based technology, mobile apps, citywide data platforms, IoT/sensors, biometrics recognition, and geospatial technology are now used by more than half of the cities in our survey of 136 metro areas. By 2021, these technologies will be table stakes for urban centers, used by three-quarters and more.

While blockchain, drones, augmented and virtual reality (AR/VR), artificial intelligence, and Vehicles to Everything (V2X) are now used by just 1 out of 10 cities, or less, these technologies will be skyrocketing in urban use over the next three years.

Blockchain will grow by 752% in use; AI, +526%; Drones/robots, +298%; Vehicles to Everything (V2X), +257%; VR/AR, +254%; and chatbots, +173%.

Q: Which of the following digital technologies does your city currently actively use to support operations?

Technologies that cities use now and plan to use in three years

	Now	3 years	*Increase*
Cloud-based technology	92%	94%	*+2%*
Mobile apps	87%	88%	*+2%*
City-wide data platform	68%	76%	*+11%*
IoT/sensors/wearables	61%	89%	*+46%*
Biometrics/facial recognition	56%	74%	*+33%*
Geospatial technology	55%	80%	*+45%*
Low-powered area-wide networks	49%	65%	*+33%*
Collaborative open source platforms	48%	68%	*+41%*
Telematics	26%	43%	*+69%*
Chatbots/natural language processing	20%	54%	*+173%*
Smart beacons/near-field communications	14%	32%	*+126%*
V2X	10%	37%	*+257%*
Artificial intelligence/machine learning	9%	55%	*+526%*
Augmented and virtual reality	8%	29%	*+254%*
Drones and robots	6%	24%	*+298%*
Blockchain	4%	38%	*+752%*

Keeping pace with digital innovation

Technological innovation is progressing faster than many cities can react. Beginners are significantly behind in the adoption of many game-changing technologies, such as IoT, biometrics, chatbots, smart beacons, and AI.

With smart cities out in front in the digital race, and technological change happening at hyper-speed, cities that fail to adopt these technologies now may become less competitive and attractive to businesses and consumers in an increasingly digital marketplace.

Q: Which of the following digital technologies does your city currently actively use to support operations?

Current use of digital technology to support operations
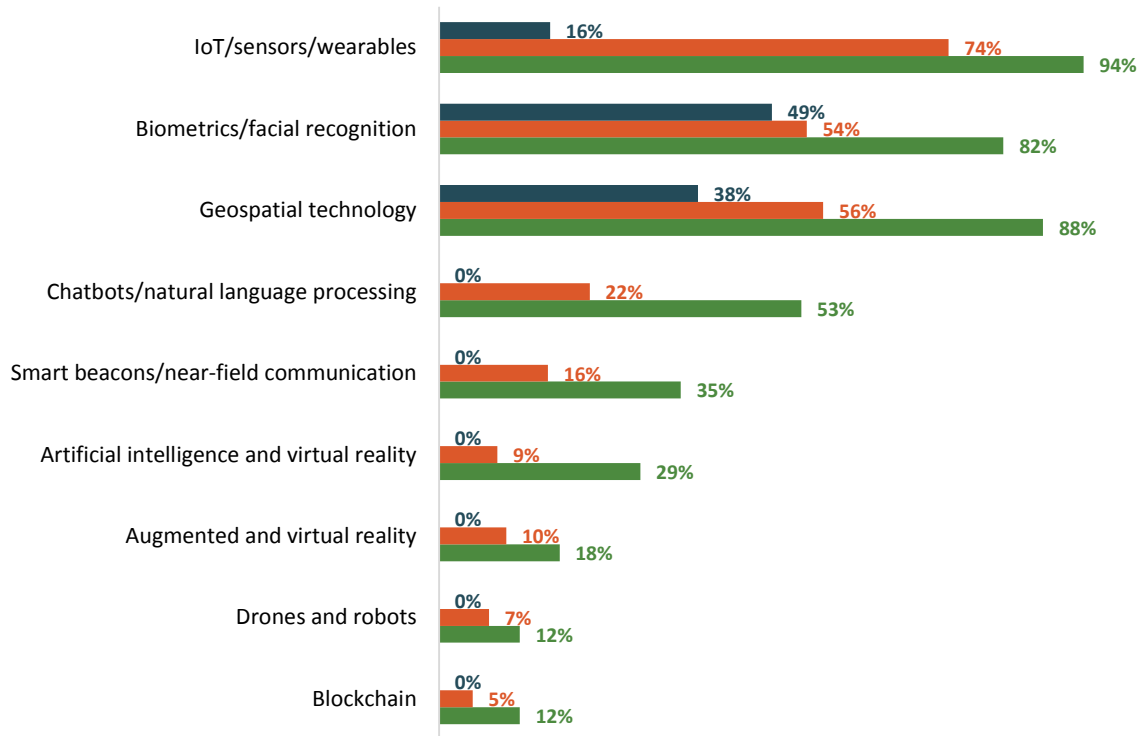
IoT/sensors/wearables — Beginner 16%, Transitioning 74%, Leader 94%
Biometrics/facial recognition — Beginner 49%, Transitioning 54%, Leader 82%
Geospatial technology — Beginner 38%, Transitioning 56%, Leader 88%
Chatbots/natural language processing — Beginner 0%, Transitioning 22%, Leader 53%
Smart beacons/near-field communication — Beginner 0%, Transitioning 16%, Leader 35%
Artificial intelligence and virtual reality — Beginner 0%, Transitioning 9%, Leader 29%
Augmented and virtual reality — Beginner 0%, Transitioning 10%, Leader 18%
Drones and robots — Beginner 0%, Transitioning 7%, Leader 12%
Blockchain — Beginner 0%, Transitioning 5%, Leader 12%

■ Beginner ■ Transitioning ■ Leader

Cities are not paying enough attention to cybersecurity

Our survey of 136 cities reveals that only about a third are well prepared for cyberattacks. The majority are only slightly or moderately prepared.

Beginning cities are particularly vulnerable. None of them said they were well prepared for cyberattacks and almost three quarters described themselves as only slightly prepared.

Even smart city leaders have exposures. About 24% said they were only moderately prepared, although their high use of digital technologies multiplies their risk of cyberattacks. None were just slightly prepared.

Q: Overall, how well prepared is your city for cyberattacks?

Current use of digital technology to support operations
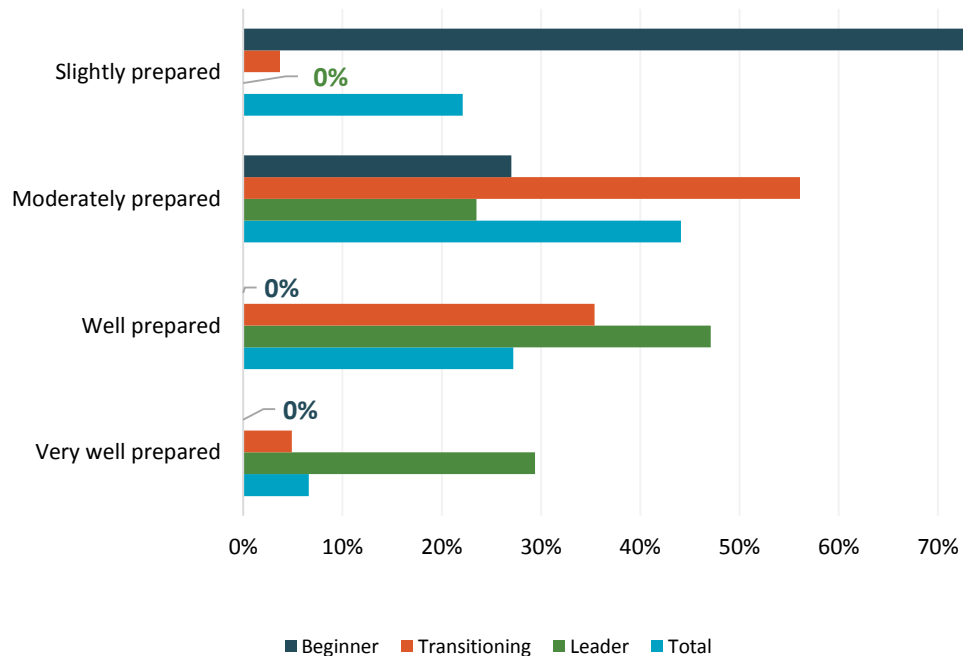
Chart legend: ■ Beginner ■ Transitioning ■ Leader ■ Total

Categories (top to bottom): Slightly prepared (0%), Moderately prepared, Well prepared (0%), Very well prepared (0%)

Cities rely on a wide array of technology adoption methods

When adopting new technologies, cities rely both on internal teams and external ecosystems of suppliers and partners.

Leaders draw on a wide range of internal and external approaches, with over half outsourcing implementation to consultants, partnering with technology providers, and licensing or buying the technology.

Transitioning cities, like leaders, tend to partner with technology providers or buy or license the technologies. But they are more likely to partner with academic institutions or service providers than outsource implementation to consultants.

Beginners are more apt to partner with service and technology providers, and license rather than buy the technology.

Q: When adopting new technologies, what approach is your city most likely to take?

Current digital adoption methods of cities
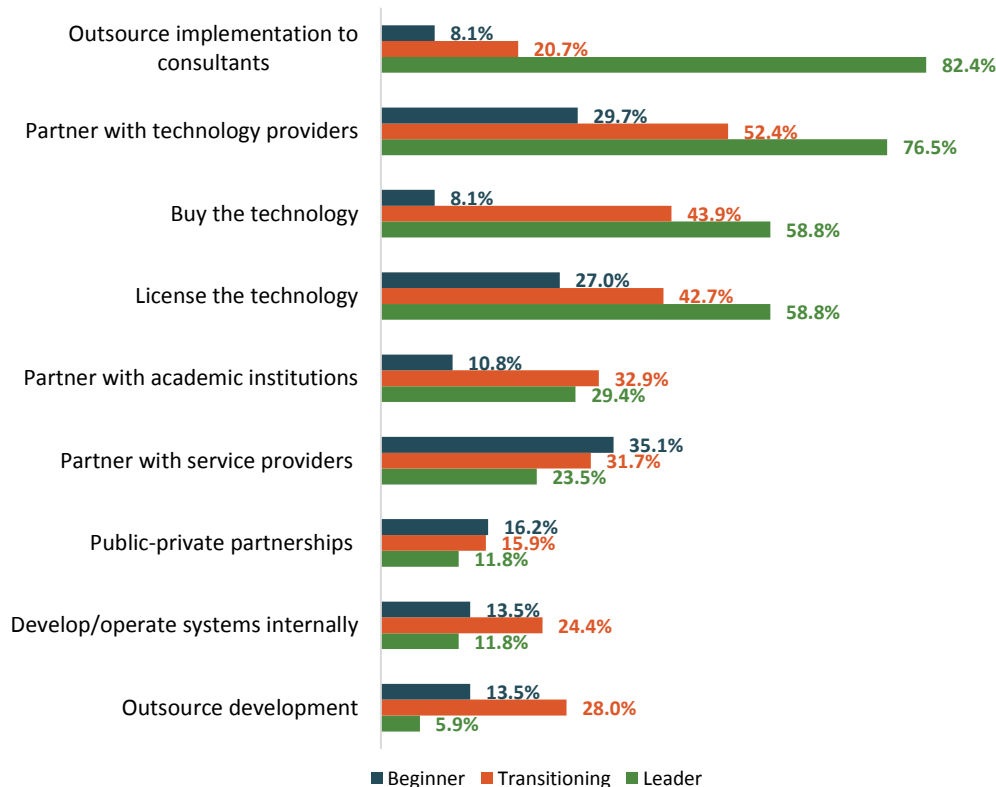
Method	Beginner	Transitioning	Leader
Outsource implementation to consultants	8.1%	20.7%	82.4%
Partner with technology providers	29.7%	52.4%	76.5%
Buy the technology	8.1%	43.9%	58.8%
License the technology	27.0%	42.7%	58.8%
Partner with academic institutions	10.8%	32.9%	29.4%
Partner with service providers	35.1%	31.7%	23.5%
Public-private partnerships	16.2%	15.9%	11.8%
Develop/operate systems internally	13.5%	24.4%	11.8%
Outsource development	13.5%	28.0%	5.9%

■ Beginner ■ Transitioning ■ Leader

Spending on smart programs rises with smart city maturity

As cities move up the smart city maturity curve, so does their spending on smart city projects as a proportion of their operating and capital budgets.

For example, beginning cities allocate 15% of their capital budgets to smart programs, while leaders apportion about 20%.

Government officials will want to make sure that they are investing enough of their budgets into the smart future and not falling behind peer cities.

% of operating budget

Beginner	Transitioning	Leader
15%	15%	16%

% of capital budget

Beginner	Transitioning	Leader
15%	17%	20%
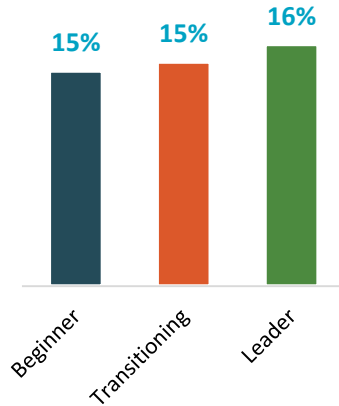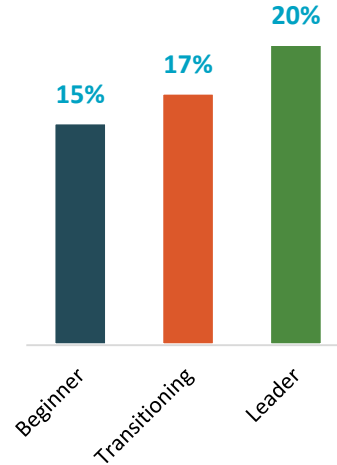
Q: What % of your annual budget is directed towards smart city investments?

Where are the leaders investing?

Across all maturity levels, cities are investing the most in mobility, environment, governance, and infrastructure.

For some pillars (mobility, environment, governance, economy, payments), the level of investment increases as cities become more mature, while in others investment falls (talent, infrastructure, public safety).

Beginner cities invest the most in infrastructure and mobility, while leaders spend the most on governance.

Q: How are your smart city investments distributed across the following areas?

How smart city leaders are investing in technology across the 10 pillars

Pillar	Beginner	Transitioning	Leader
Mobility	15.5%	14.6%	14.9%
Environment	13.4%	14.6%	14.2%
Governance	13.2%	14.0%	15.5%
Infrastructure	15.8%	10.1%	8.9%
Economy	7.0%	10.7%	11.2%
Public safety	7.8%	7.9%	7.8%
Health	7.5%	7.6%	8.5%
Budget	6.8%	7.4%	6.2%
Payments	6.2%	7.2%	7.2%
Talent	6.8%	5.7%	5.4%

■ Beginner   ■ Transitioning   ■ Leader

Balancing brownfield and greenfield initiatives

With urban populations rising, governments continue turning to greenfield development—new cities or new neighborhoods at the fringes of metropolitan areas. This offers an opportunity to begin anew allowing the deployment of smart city approaches and techniques that can attenuate sprawl, minimize ecological damage, build in multimodal transit, and optimize land, water, and energy use, while including the necessary elements to sustain urban populations.

Greenfield developments can serve as testing grounds for innovative ideas that can be applied to existing urban areas. This is the approach that governments in India and South Korea, which are dealing with explosive growth, are taking, where they are building new cities with the latest smart city technologies, while simultaneously retrofitting their older cities to meet challenges they weren't built to handle.

In India, for example, Prime Minister Narendra Modi this year officially inaugurated the new city of Naya Raipur, which includes solar power, rainwater harvesting, fiber optic and mobile connectivity, bike-sharing, a city-wide digital dashboard, an underground utility corridor, and LED streetlighting. Similar innovations are being integrated in built-out cities, such as Toronto, which is working with Alphabet's Sidewalk Labs to transform part of the city's waterfront into a futuristic district, replete with autonomous vehicles, multi-modal transit, affordable housing, and sustainable energy.

Greenfield development offers insights and societal benefits; however, governments still need to find ways to apply these lessons for existing urban area redevelopment. One future vision is a "multifields" model for comprehensive planning that includes greenfield and brownfield development, together with optimal utilization of underground space, vacant fields, sky, time fields, and other configurations. Whatever path is followed, ultimately it will have to balance the challenges of urban growth with the obligation to address current citizen needs at all ends of the demographic spectrum.
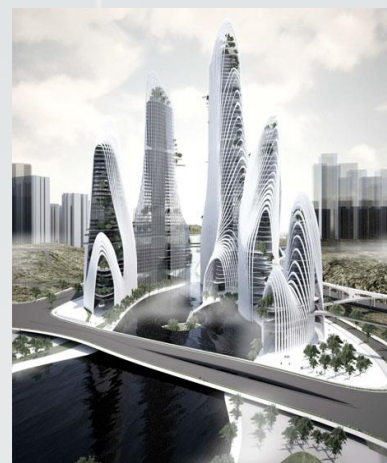
The 10 Pillars of Smart City Success

"Cities should build on each other's progress and learn from each other's efforts. In facing similar challenges, cities have the opportunity to establish common goals and standards. Digital solutions make it possible for cities to make the journey to progress together."

- Miguel Gamiño Jr, Head of Global Cities, Mastercard.

The 10 pillars of smart city transformation

Our research identified 10 smart city pillars that work together to drive benefits to local stakeholders. While urban leaders will vary their approaches based on the issues their cities face, the most successful cities create roadmaps that build on foundational and tech-enabled pillars. As part of our research, we asked government leaders, citizens and businesses to give us their views on these 10 pillars for smart city success. This section shows their ranking of priorities on a scale of 0-4.

0 = not a priority

1 = low priority

2= medium priority

3 = high priority

4 = very high priority

Tech-enabled pillars
- PAYMENTS
- PUBLIC HEALTH
- PUBLIC SAFETY
- ENVIRONMENT
- MOBILITY

Foundational pillars
- INFRASTRUCTURE
- FUNDING
- TALENT
- ECONOMY
- GOVERNANCE

Cities focus more on the 10 pillars as they become *smarter*

With the exception of smart infrastructure, leaders give higher priorities on every dimension. Every leader in our sample placed a high priority on smart mobility, and the vast majority on smart environment, public safety, governance, and economy.

While mobility, public safety, and environment were important for beginners, very few cited talent, payments, or funding as priorities. Since talent and funding are crucial foundational stones for smart city programs, the lower emphasis on these areas may undermine the success of cities just starting their smart city journeys.

Q: What level of priority does your city place on each of the following smart city dimensions?

Smart pillar priority by level of maturity
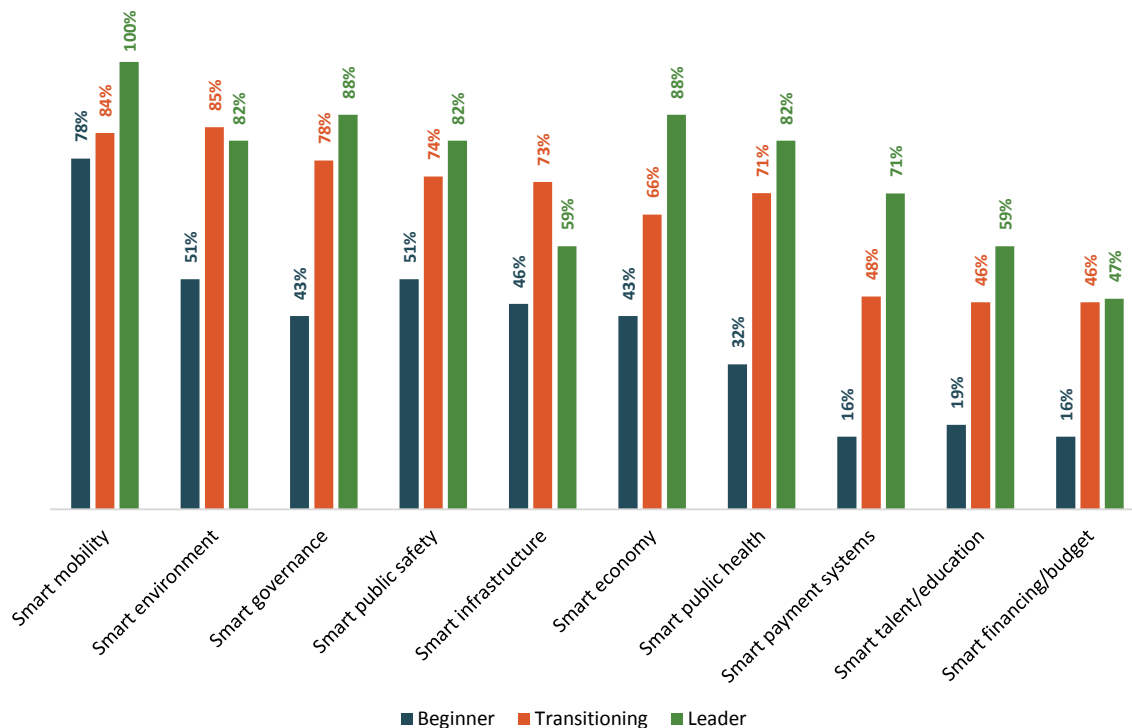
Pillar	Beginner	Transitioning	Leader
Smart mobility	78%	84%	100%
Smart environment	51%	85%	82%
Smart governance	43%	78%	88%
Smart public safety	51%	74%	82%
Smart infrastructure	46%	73%	59%
Smart economy	43%	66%	88%
Smart public health	32%	71%	82%
Smart payment systems	16%	48%	71%
Smart talent/education	19%	46%	59%
Smart financing/budget	16%	46%	47%

■ Beginner ■ Transitioning ■ Leader

35

Laying the foundation for smart city success

These five pillars—governance, economy, infrastructure, talent, and funding--provide the foundation for building a successful smart city. Without the right vision, plans, and resources in place, smart city programs will not reach their full potential.

Smart governance: developing a digitally enabled vision, supported by an properly staged implementation plan, an effective policy framework, and the buy-in of local stakeholders.

Smart economy: building an economic environment that attracts business and investment, fosters industry development, promotes e-commerce, and creates local and global trade linkages.
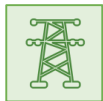
Smart infrastructure: interconnected infrastructure that optimizes buildings, roads, telecommunications, water, and other foundational services.

Smart talent: a strong academic and cultural foundation that attracts talent, encourages innovation and entrepreneurship, and nurtures the skills needed by the private and public sectors.

Smart funding: ensuring that you have the funding, budget controls, private sector partnerships, and new business models in place to finance a sustainable smart city program, which ultimately will become self-funding.

Smart Governance

Smart governance is the keystone for building a successful smart city. Step one is creating a tech-enabled vision for the city, with a cohesive implementation plan to deliver results in a manageable, cost-effective way.

To be successful, urban leaders must factor in the expectations of local citizens and businesses to ensure alignment and buy-in. Setting a policy framework that encourages innovation and adoption of smart technologies is vital for driving performance.

Unfortunately, our study shows that stakeholders believe their city leaders often do not focus enough on smart governance, particularly at the start of their smart city journey, when it is most needed.

"Successful cities reinvent themselves through a relentless focus on providing value for the citizens, businesses, and employees. They become efficient and effective enterprises, responsive and resilient, with the ability to predict trends and plan for the future."

-Jen Hawes Hewitt, Global Cities Lead, Accenture

The importance of smart governance

Despite the central role of governance to smart city transformation, only Chicago and Copenhagen, two smart city leaders, give it a very high priority. Both Athens and Lagos, both beginner cities, give governance a high priority, which should help their efforts to become smarter cities. Stakeholders in Tokyo, Shanghai, New Delhi, Moscow, Lagos, and Dubai believe that urban leaders should put a higher priority on governance. Citizens generally place a higher priority on governance than businesses.

Current priority level in each stakeholder's view

Where citizens and businesses believe priority should be

Legend: Government, Citizen, Business
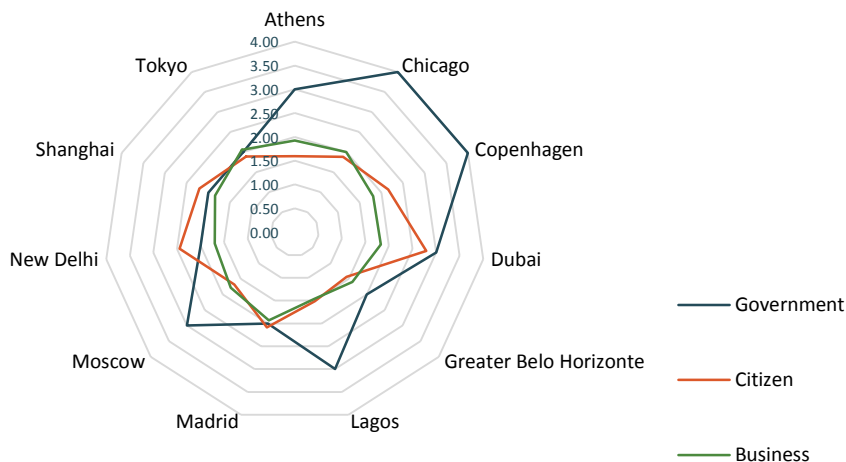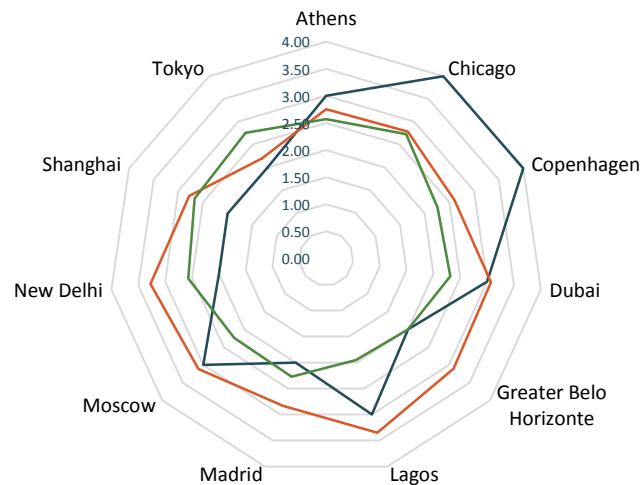
Q: What priority is placed on governance in your city? How important should it be?

Businesses are more satisfied with services than citizens

The first priority of any government is to provide efficient city services. So how are the proxy cities doing?

In general, businesses are happy with the level of service they are receiving from their government. That is particularly evident in cities that are more advanced in smart city maturity.

Citizens, on the other hand, are considerably less satisfied with current services, which is why they tend to favor smart city solutions.

Citizens in Athens, Tokyo, Moscow, Greater Belo Horizonte, and Lagos are the least satisfied with local services.

Q: Please indicate your overall level of agreement with the following statement: the overall quality of city services is high.

Business vs citizen satisfaction levels
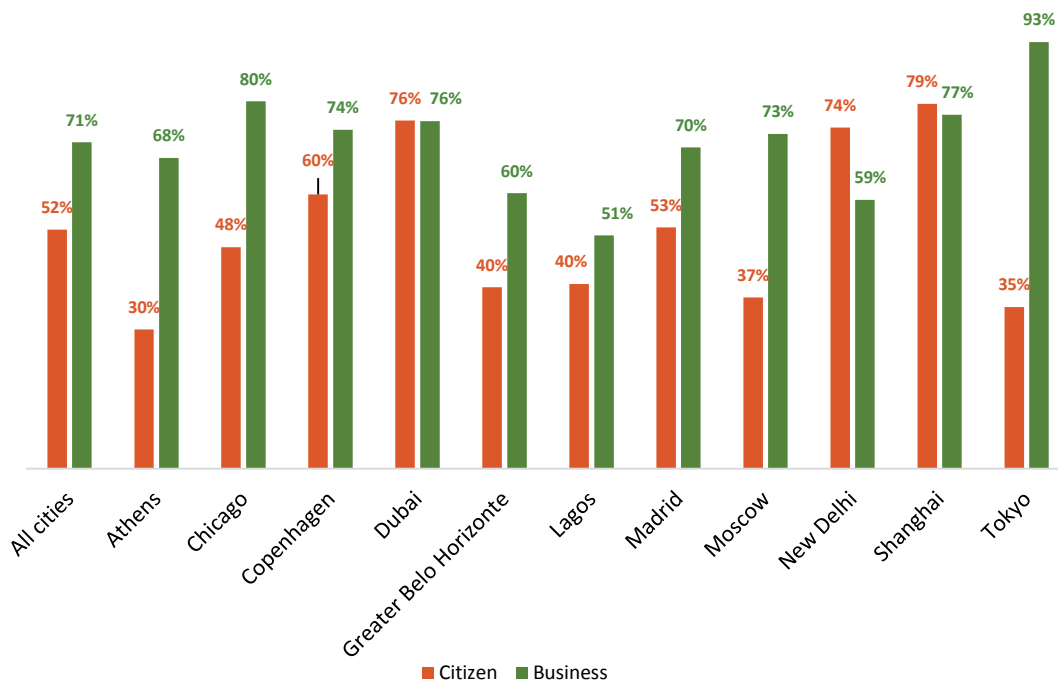
City	Citizen	Business
All cities	52%	71%
Athens	30%	68%
Chicago	48%	80%
Copenhagen	60%	74%
Dubai	76%	76%
Greater Belo Horizonte	40%	60%
Lagos	40%	51%
Madrid	53%	70%
Moscow	37%	73%
New Delhi	74%	59%
Shanghai	79%	77%
Tokyo	35%	93%

■ Citizen   ■ Business

Businesses want a say in governance and better operating conditions

When it comes to governance, local businesses want urban leaders to focus more on involving them in urban planning (47%), minimizing bribery/corruption (43%), reducing regulatory burdens (43%), offering open data platforms (42%), and updating regulations to allow innovation (42%).

In beginning cities, businesses particularly want to be engaged in urban planning (52%), have easier access to data to manage their operations (47%), and help develop a long-term urban vision (46%). In leader cities, the desire for more sharing of data (48%) and use of advanced data tools and technologies (44%) is higher than average.

In general, firms and merchants are more concerned about improving business conditions than reducing urban inefficiencies.

The areas of governance requiring attention	All	Beginner	Transitioning	Leader
Involving local business executives in planning decisions	47%	52%	46%	45%
Minimizing bribery and corruption	43%	47%	39%	43%
Reducing the burden of complying with local government regulations	43%	47%	39%	44%
Offering open data platforms across government, business, and citizens	42%	41%	38%	48%
Updating regulations in response to new, innovative business models	42%	41%	41%	43%
Providing channels for real time information and resource sharing	41%	44%	37%	43%
Making it easy to find, access, and bid on procurement opportunities	41%	45%	41%	38%
Quickly resolving city issues that affect my business	40%	40%	40%	40%
Ensuring a stable fiscal environment	40%	43%	39%	38%
Using advanced data and technologies to improve urban decision making	40%	39%	35%	44%
Making it easy to access information and data to manage our business	38%	47%	32%	39%
Developing a long-term vision for the city	35%	46%	29%	32%
Ensuring a stable policy environment for doing business	31%	36%	25%	32%
Decreasing city inefficiencies	21%	21%	17%	24%

Q: In your view, what level of attention should your city put on the following areas of city governance?

Citizens are far more satisfied living in smarter cities

Citizens in both transitioning and leader cities are generally satisfied with life in those cities, the services that are available, and the way their cities are managed.

But it is a different story for inhabitants of beginner cities. They feel their cities are less able to provide efficient services or make effective decisions, and less open to new ideas, technology, and citizen input into urban decisions. In addition, they believe their cities care less about citizens and suffer more from corruption.

On the plus side, they are more willing to pay for improved services, which may offer a funding opportunity to cities setting out on their smart journeys.

Citizens' views on the cities they live in	Leader	Transitioning	Beginner
Information about city programs and services is widely available.	65%	66%	43%
My city is well managed and makes effective decisions.	62%	63%	45%
My city provides efficient services to its citizens.	61%	62%	38%
My city is a good place to work and start a business.	60%	66%	57%
My city government is open to new, innovative technology and ideas.	58%	62%	46%
My city is a good place to live and raise children.	57%	67%	55%
The overall quality of city services is high and delivered with the citizen in mind.	56%	60%	37%
My city government cares about citizens and invests in my community.	55%	58%	36%
It is easy to interact with city departments and agencies.	54%	57%	36%
There are effective channels for citizens to give their input into city decisions.	54%	57%	34%
I would be happy to pay a premium for improved city services.	48%	59%	59%
My city's government suffers from corruption.	38%	56%	65%
I plan to move out of my city over the next five years.	35%	39%	44%

Q: Please indicate your level of agreement with the following statements. Select one in each row (top 2-box scores).
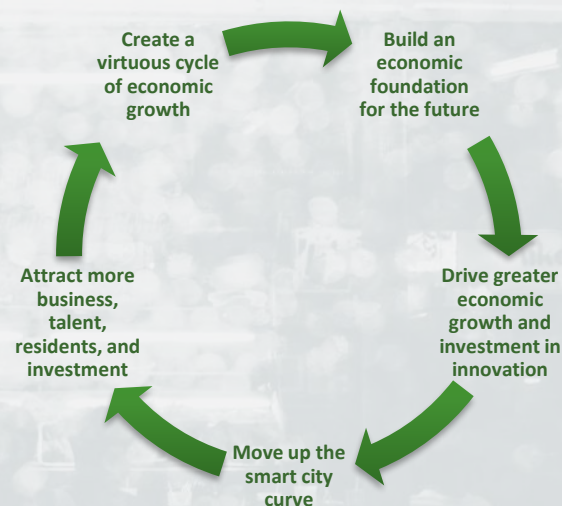
Smart Economy

Laying a strong foundation for smart city growth requires a cogent economic development plan for attracting business and investment, fostering industry development, promoting e-commerce, and creating new local and global trade linkages. As they embark on their smart city journey, cities need to ensure they have an economic foundation in place that will allow their cities to succeed in today's fourth industrial revolution. With digital technology, industrial sectors, global linkages, and customer behaviors in a state of rapid flux, cities have to replace old economic models built on single industries or skill sets that are no longer relevant.

Our study found that as cities move up the smart city maturity curve, they put a higher priority on economics: 43% of beginners prioritize smart economy initiatives, compared with 66% of transitioning cities, and 88% of leaders. But to reap the full benefits, cities should put their economies on a stronger footing as they begin their smart city transformation programs. Cities that adapt their economic models are better equipped to drive economic growth, competitiveness, and investment in innovation. As these cities move up the smart city maturity curve, they become more attractive to businesses and residents, which creates a virtuous cycle of economic growth.

The virtuous cycle of economic growth

Create a virtuous cycle of economic growth

Build an economic foundation for the future

Drive greater economic growth and investment in innovation

Move up the smart city curve

Attract more business, talent, residents, and investment

Smart economy is a growing priority for both citizens and businesses

According to our survey of 136 cities, urban centers in advanced markets put a higher priority on economics (70%) than cities in emerging markets (47%). For example, three advanced market proxy cities in our deep-dive analysis, Chicago, Tokyo, and Athens, gave smart economy a very high priority, vs just one emerging-market city, Dubai. Both businesses and citizens across all the proxy cities would like their governments to put a higher priority on building a strong economic foundation.

Current priority level in each stakeholder's view

Legend:
— Government
— Citizen
— Business
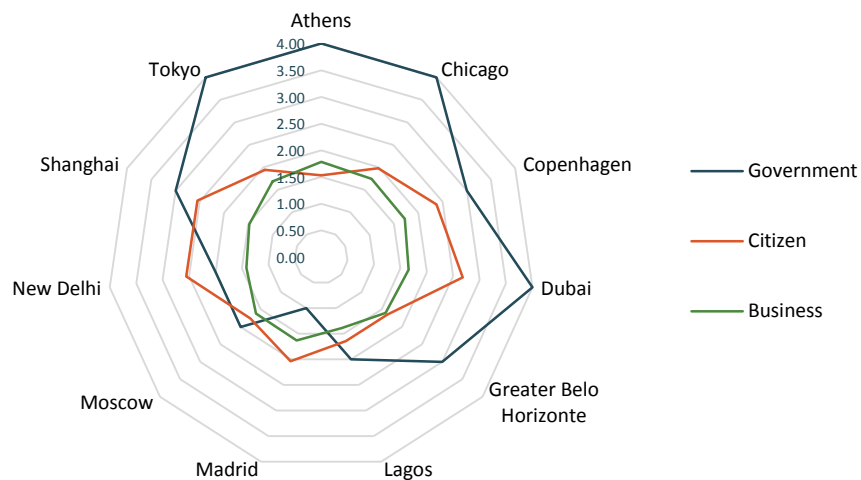
Where citizens and businesses believe priority should be
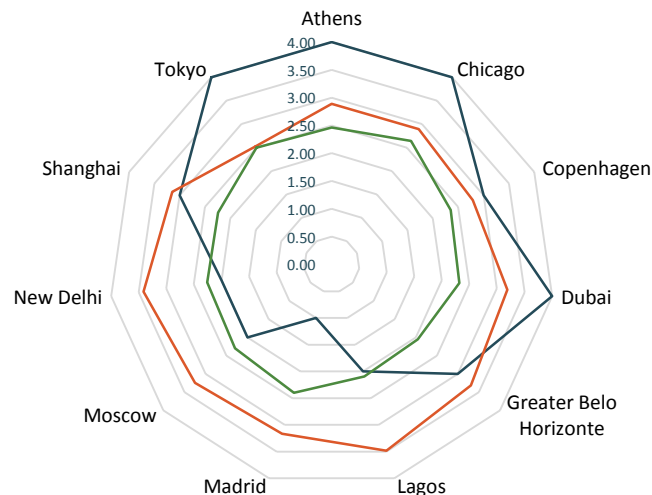
Q: What priority is placed on economy in your city? How important should it be?

Economic issues are important for businesses across maturity stages

Given their dependence on healthy business conditions, companies and merchants often rank economic issues high on their lists. However, the importance of these issues vary by the stage of smart city maturity.

For example, businesses in beginner cities are far more concerned about building jobs and opportunities than cities further along the maturity curve. Conversely, smart city leaders, which tend to attract more people, see coping with business growth as a critical issue.

Top issues facing businesses by maturity level

Improving business attractiveness
- Leader: 22%
- Transitioning: 19%
- Beginner: 25%

Ensuring inclusiveness/income equality
- Leader: 17%
- Transitioning: 22%
- Beginner: 11%

Driving economic development
- Leader: 22%
- Transitioning: 21%
- Beginner: 18%

Coping with population growth
- Leader: 26%
- Transitioning: 20%
- Beginner: 15%

Building jobs and business opportunities
- Leader: 6%
- Transitioning: 9%
- Beginner: 21%

■ Leader   ■ Transitioning   ■ Beginner

Q: In your opinion, what are the top three issues facing your city?
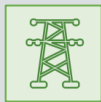
Smart Infrastructure

Smart infrastructure is a high priority for almost two-thirds of surveyed cities, which see electricity, telecommunications, water, sewerage, buildings, and roads as essential building blocks for smart city development. As cities move up the smart city maturity curve, they are more apt to use smart initiatives to deal with inadequate and obsolete infrastructure. For example, about two-thirds of leaders said it is a major challenge that they are tackling through smart initiatives vs 16% of beginners.

The path to expanded digital connectivity, the lynchpin for smart technologies, can vary city by city. Early adopters need to replace legacy systems with new technologies, while late-comers to the digital revolution sometimes have been able to leap-frog to mobile solutions.

In addition to upgrading their digital capacity, beginners also often face a challenge in ensuring that their cities meet basic requirements of clean water and streets – keys to retaining citizens. And as their city progresses, businesses seek to modernize the infrastructure needed to connect to global markets, including airports, shipping ports, and trade networks.

"Given the accelerating urbanization occurring globally, infrastructure is one of the most important critical elements to sustainable communities.
The implementation of smart solutions will ensure that the optimization of the investments made will have an enduring impact on the health, safety, and economic development of communities around the world."
-Anthony S. Bartolomeo, President and CEO, Pennoni

"Smart city initiatives have great potential to raise the efficiency and amenity of cities, with consequent gains in real estate values. This can take the form of a local boost to values or even to step changes in the status and value profile of cities in emerging markets.
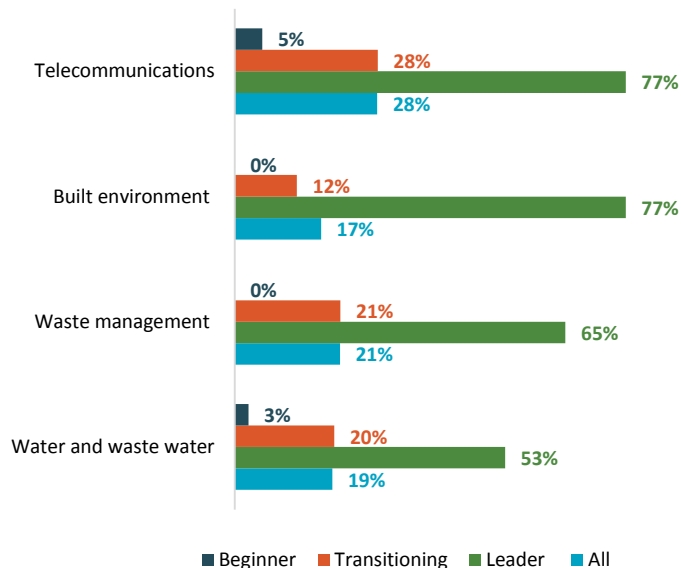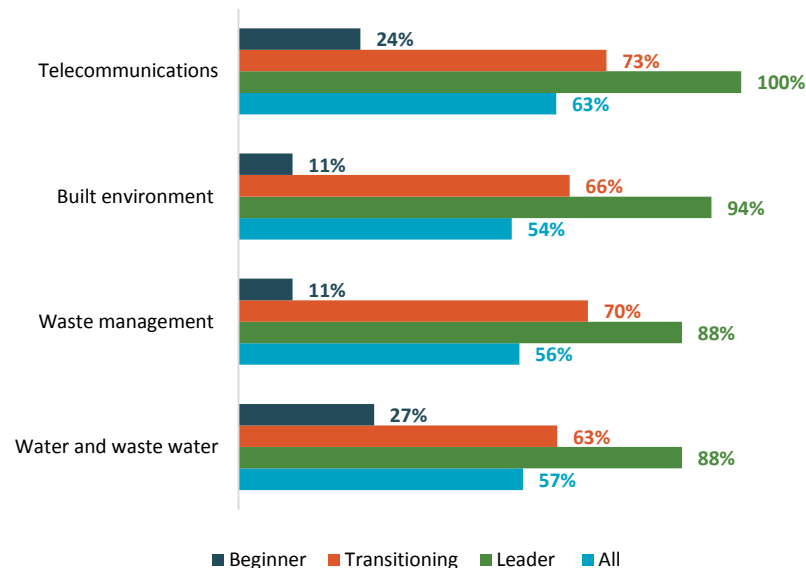-Richard Holberton, Senior Director EMEA Research, CBRE
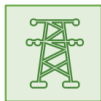
Cities across the board are planning infrastructure upgrades

According to McKinsey, a consultancy, the world today invests about $2.5 trillion per year in transportation, power, water, and telecommunications systems. But with urban populations growing, many infrastructure areas are under pressure. Our study found that cities across all smart city maturity levels are planning to advance their infrastructure agenda.

Advanced stages of infrastructure now

	Beginner	Transitioning	Leader	All
Telecommunications	5%	28%	77%	28%
Built environment	0%	12%	77%	17%
Waste management	0%	21%	65%	21%
Water and waste water	3%	20%	53%	19%

Advanced stages of infrastructure in three years

	Beginner	Transitioning	Leader	All
Telecommunications	24%	73%	100%	63%
Built environment	11%	66%	94%	54%
Waste management	11%	70%	88%	56%
Water and waste water	27%	63%	88%	57%

■ Beginner ■ Transitioning ■ Leader ■ All

Infrastructure reliability is a key concern

According to our citizen survey, reliability of basic infrastructure remains an issue in some of our proxy cities, particularly in Lagos, where problems with electricity supply and fixed broadband are likely to severely hamper smart city initiatives. However, citizens of some other developing cities, particularly Shanghai and New Delhi (where Prime Minister Narendra Modi's nationwide push to improve electricity supply is working), give their infrastructure higher marks than do those in highly developed cities like Copenhagen and Tokyo. Of course, these rankings are subject to citizen expectations, which may be higher in advanced markets.

Reliability of infrastructure by city

	All cities	Athens	Chicago	Copenhagen	Dubai	Greater Belo Horizonte	Lagos	Madrid	Moscow	New Delhi	Shanghai	Tokyo
Airports and control towers	63%	61%	67%	52%	67%	61%	59%	66%	52%	82%	78%	44%
Mobile connectivity	62%	55%	68%	62%	68%	56%	45%	66%	59%	80%	79%	46%
Electricity supply (lack of interruptions and fluctuations)	61%	58%	70%	53%	69%	60%	15%	63%	56%	82%	84%	61%
Postal offices and mail delivery	60%	51%	68%	49%	64%	59%	43%	65%	41%	77%	79%	61%
Water supply (lack of interruptions and flow fluctuations)	59%	60%	66%	60%	66%	55%	28%	66%	45%	69%	78%	56%
Roads, tunnels, and bridges	58%	45%	58%	59%	69%	57%	38%	63%	45%	75%	80%	48%
Fixed broadband (lack of interruptions and speed fluctuations)	56%	44%	62%	55%	64%	54%	21%	65%	53%	76%	81%	46%
Sewer system, and waste management facilities	53%	46%	62%	56%	65%	49%	24%	59%	6%	65%	70%	51%

Q: How reliable are the following areas of infrastructure in your city? Select one in each row (top 2-box scores).

# Both citizens and business would pay more for better infrastructure

Infrastructure is a particular problem for businesses and citizens in cities just beginning their smart journey transformation. Residents in these cities often lack access to public Wi-Fi and smart building technology, and fiber-optic cable is not widely available to businesses.

On the plus side, over 50% of businesses across maturity levels believe that their city's infrastructure can support increased commercial activities with global markets.

Most tellingly, over 50% of both citizens and businesses across all stages of maturity are willing to pay more for improvements in basic infrastructure.

Q: Please indicate how strongly you agree or disagree with the following statements. (Displaying strongly agree or agree.)

Businesses' views on infrastructure
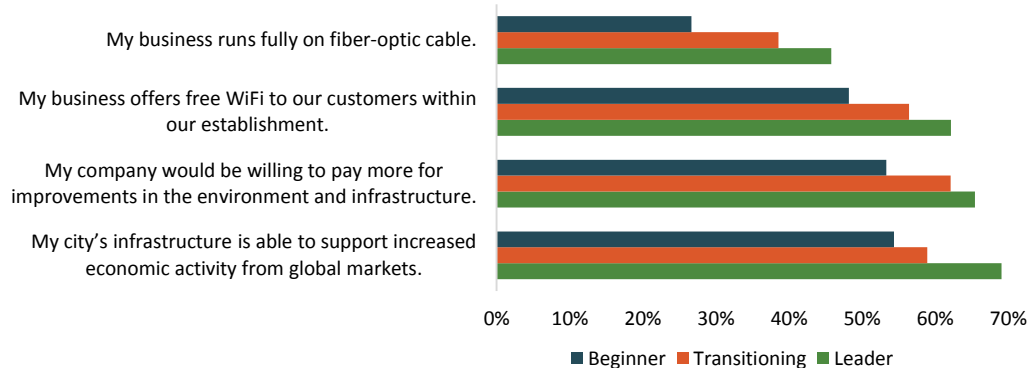
Citizens' views on infrastructure
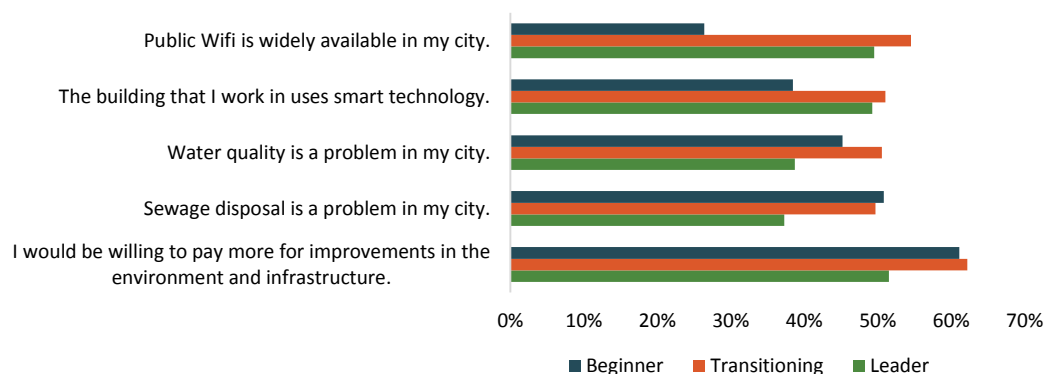
Unreliable electricity spurs perceived need for smart energy investment

Unsurprisingly, citizens experiencing higher electricity instability in their city believe there is a stronger need for investment in smart technologies that will increase reliability, from smart grids with embedded sensors to energy generation from renewable resources and micro-grids.

Average number of outages per year and citizens' sentiment on need for investment in energy technologies

Legend:
- Average number of outages per year
- Focusing on distributed generation from renewable sources and micro-grids
- Improving coordination of power generation and power demand
- Installing smart grids that use embedded sensors to manage water, gas, and electric services
- Providing data to help make businesses and consumers more aware of their energy use

Left axis: Average outages per year
Right axis: Level of investment wanted by citizens in smart energy technologies

Cities: Lagos, New Delhi, Shanghai, Greater Belo Horizonte, Moscow, Dubai, Chicago, Madrid, Athens, Copenhagen, Tokyo

Q: Primary axis: How often does your power go out? Secondary axis: Please indicate how strongly you agree or disagree with the following statements. (Displaying strongly agree or agree.)

Smart Talent

Talent is the lifeblood of smart cities, yet many cities are not doing enough to nurture the workers and skills needed for the digital age. While there is not a single formula to attract and retain talent, the most successful cities have built urban centers that cultivate academic partnerships, develop vibrant technology sectors, encourage entrepreneurship, and create a local cultural hub that attracts creative talent.

The entire economy benefits from the influx of tech talent. Enrico Moretti, an economist from the University of California, estimates that for every college graduate that accepts a job in the tech industry, five additional jobs are created within the city.

Pittsburgh is a good example. It transformed itself from a "Rust Belt" city dependent on an eroding steel industry to a "Brain Belt" city widely lauded as a center of excellence in robotics and artificial intelligence. Pittsburgh was not reinvented overnight. While Carnegie Mellon University's establishment of the Robotics Institute was the defining moment, it was the interplay of the city's government with academic institutions, private businesses, and entrepreneurs that drove the city's remarkable transformation into "Roboburgh."

"There is a very strong track record of places that attract talent becoming places of long-term success."

-Edward Glaeser, Professor of Economics, Harvard University

"Smart, innovative workers like to be around smart, innovative workers."

-Enrico Moretti, Professor of Economics, University of California, Berkeley

Many cities are still not focusing enough on talent

Although talent is the lifeblood of urban growth and innovation, over half of the proxy cities gave only medium priority to talent. Businesses and citizens recognize that talent and education are the key to their own success and their city's economic future. Both groups have rising expectations across the board, which could mean that cities like Athens, Greater Belo Horizonte, Chicago, Moscow, Shanghai, and Copenhagen, which rate talent lower as just a medium priority, may want to listen to their stakeholders.

Current priority level in each stakeholder's view

Where citizens and businesses believe priority should be

Legend: Government, Citizen, Business
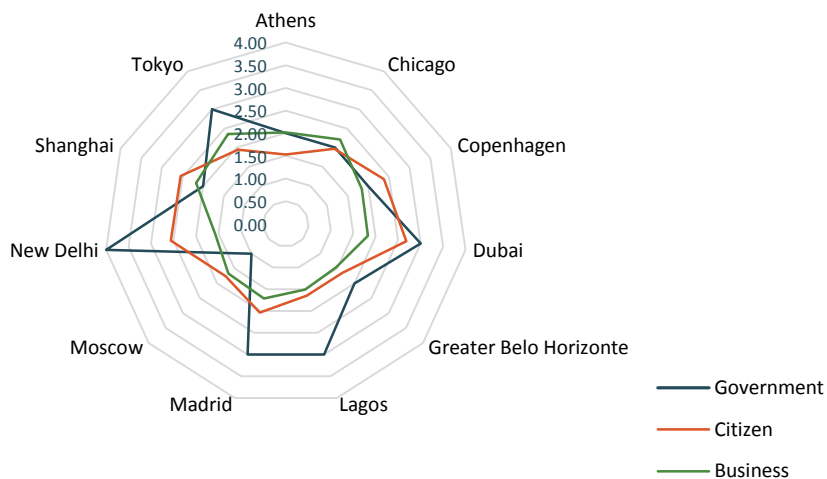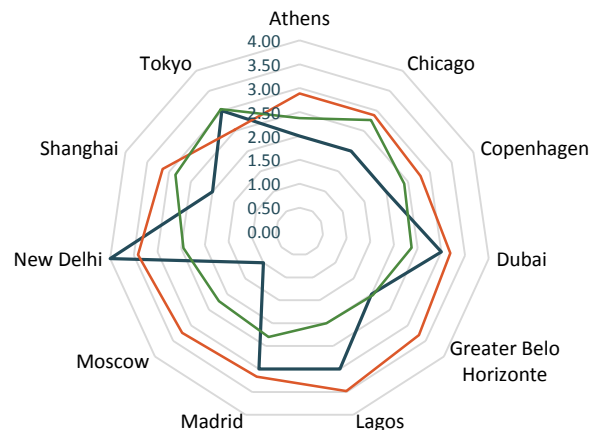
Q: What priority is placed on talent and education in your city? How important should they be?

Smart city leaders do more to nurture talent and digital skills

Smart city leaders tend to do more to develop talent, according to businesses operating in these cities. Quality public education and technical skills are more widely available. Still, these businesses would like their cities to do more to drive talent, such as partner more with universities to provide open online education or co-produce programs that teach job-specific skills.

What businesses think about their city's talent pool
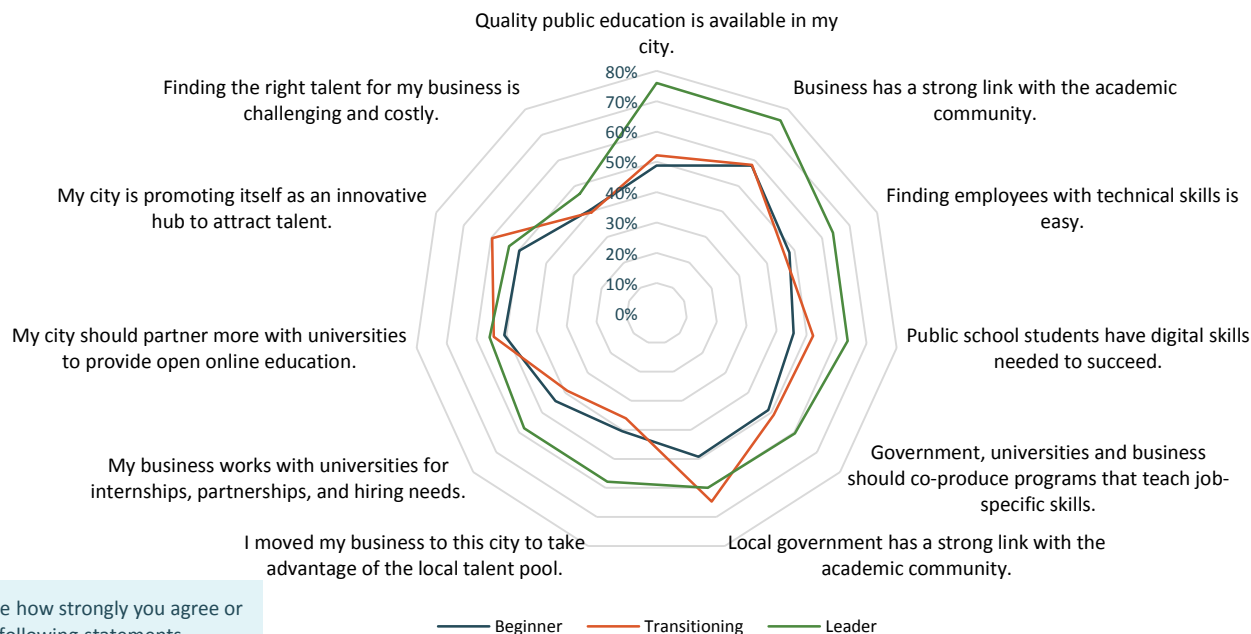
Q: Please indicate how strongly you agree or disagree with the following statements. (Displaying strongly agree or agree.)
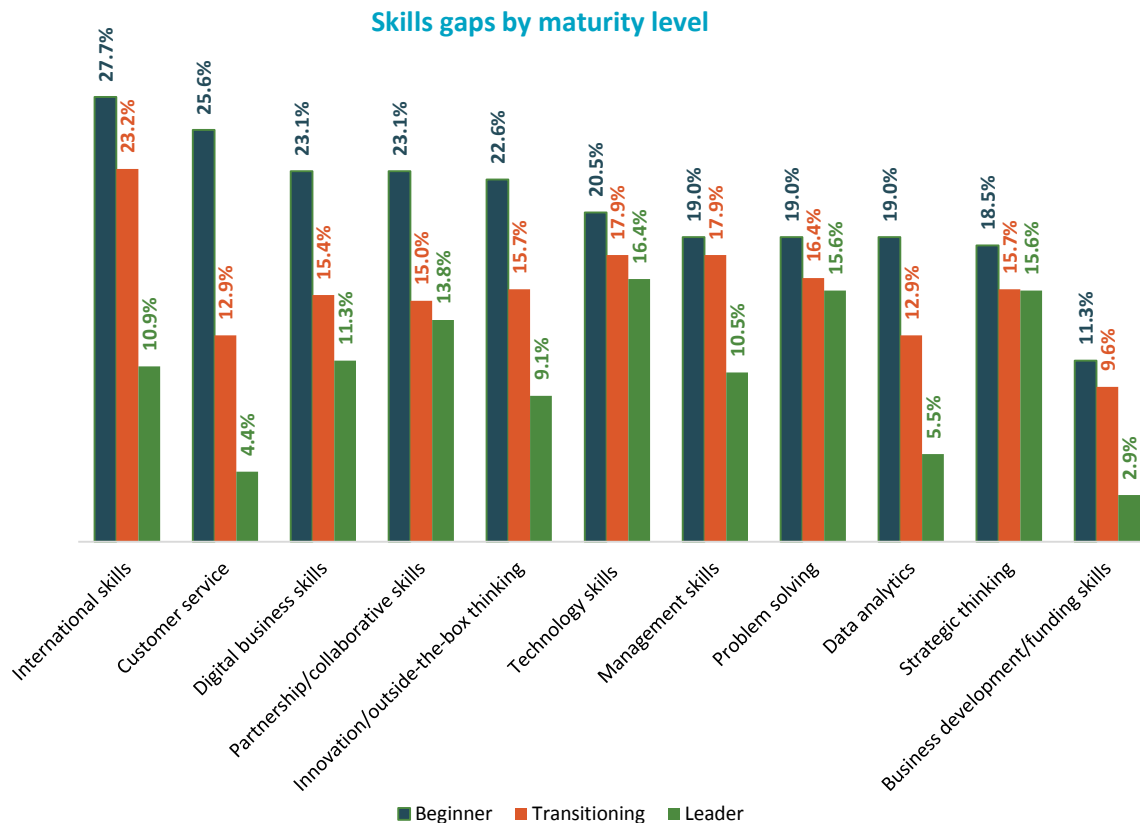
International skills are the biggest gap for early-stage smart cities

While businesses were reasonably satisfied with education and talent in their cities, they recognize gaps that can be filled.

Businesses in leader cities feel their largest gap is in technology skills, while international skill gaps are looming for transitioning and beginner cities.

This combination—crucial data skills and the ability to connect with the global marketplace—are key for both smart city and economic success for all potential smart cities.

Q: Where are the biggest skill gaps for your company? Select one in each row.

Skills gaps by maturity level

Skill	Beginner	Transitioning	Leader
International skills	27.7%	23.2%	10.9%
Customer service	25.6%	12.9%	4.4%
Digital business skills	23.1%	15.4%	11.3%
Partnership/collaborative skills	23.1%	15.0%	13.8%
Innovation/outside-the-box thinking	22.6%	15.7%	9.1%
Technology skills	20.5%	17.9%	16.4%
Management skills	19.0%	17.9%	10.5%
Problem solving	19.0%	16.4%	15.6%
Data analytics	19.0%	12.9%	5.5%
Strategic thinking	18.5%	15.7%	15.6%
Business development/funding skills	11.3%	9.6%	2.9%

■ Beginner ■ Transitioning ■ Leader

Smart Funding

According to the UN, 54% of the world's population lives in cities, and that percentage will rise to two-thirds by 2050. Funding the smart city solutions needed to met the demands of growing populations will become a challenge for most cities in the future. Mature cities will be tasked with updating their legacy infrastructure, while nascent cities will need to build smarter systems from the start.

To finance these smarter technologies and services, cities will need to be more innovative in their funding techniques, sources of capital, budget approaches, and business models. Unfortunately, smart funding is one of the most overlooked pillars for cities starting their smart city journey. But without proper funding a smart city program cannot succeed.

"Many cities simply don't have pockets deep enough to pay for needed improvements, enhancements, and expanded services that citizens demand and growing populations require."
-Doug Peeples, Associate Editor, Smart City Council

"Finding money for innovation projects is difficult, particularly in an era of shrinking budgets. Modernizing front- and back-office operations with the cloud can produce savings that could fund those critical programs."
-Susan O'Connor, Global Director, Public Sector Industry Marketing, Oracle

Citizens want to see cities place more priority on finance

As cities move forward on their smart city journeys, how they finance those improvements must be a priority, according to businesses and citizens in the proxy cities. With the exception of Tokyo, citizens' expectations meet or exceed the current priority that their governments are placing on finance.

Current priority level in each stakeholder's view

Where citizens and businesses believe priority should be

Legend:
— Government
— Citizen
— Business
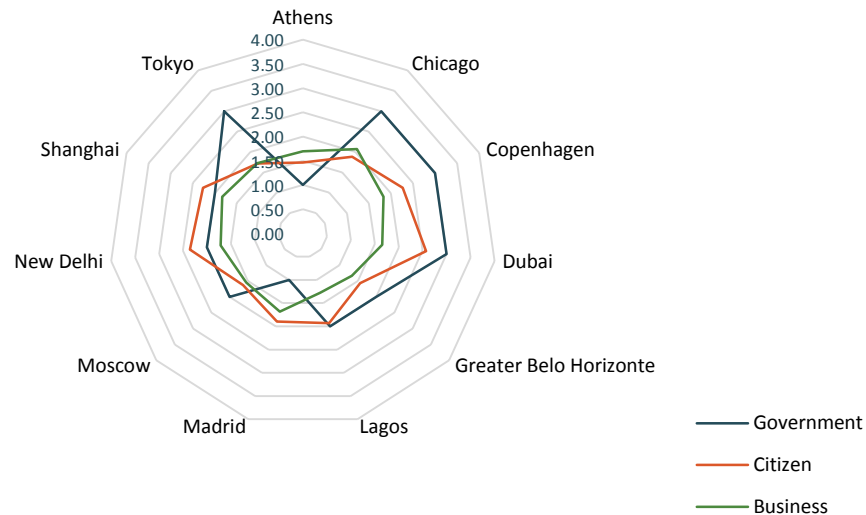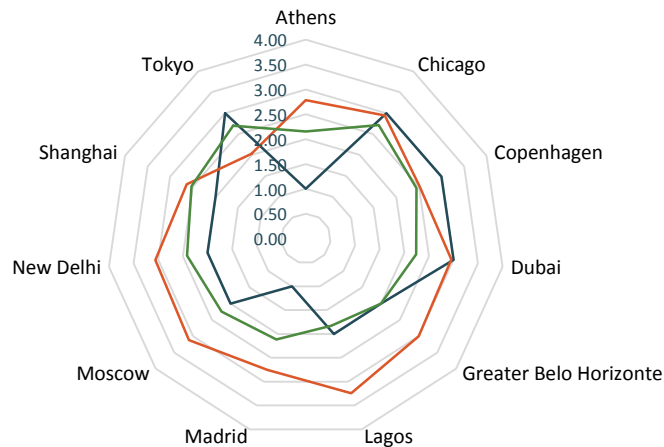
Q: What priority is placed on finance and budgeting in your city? How important should it be?

Introduction

Research Methodology

The Path to a
Smart City Future

The 10 Pillars of
Smart City Success

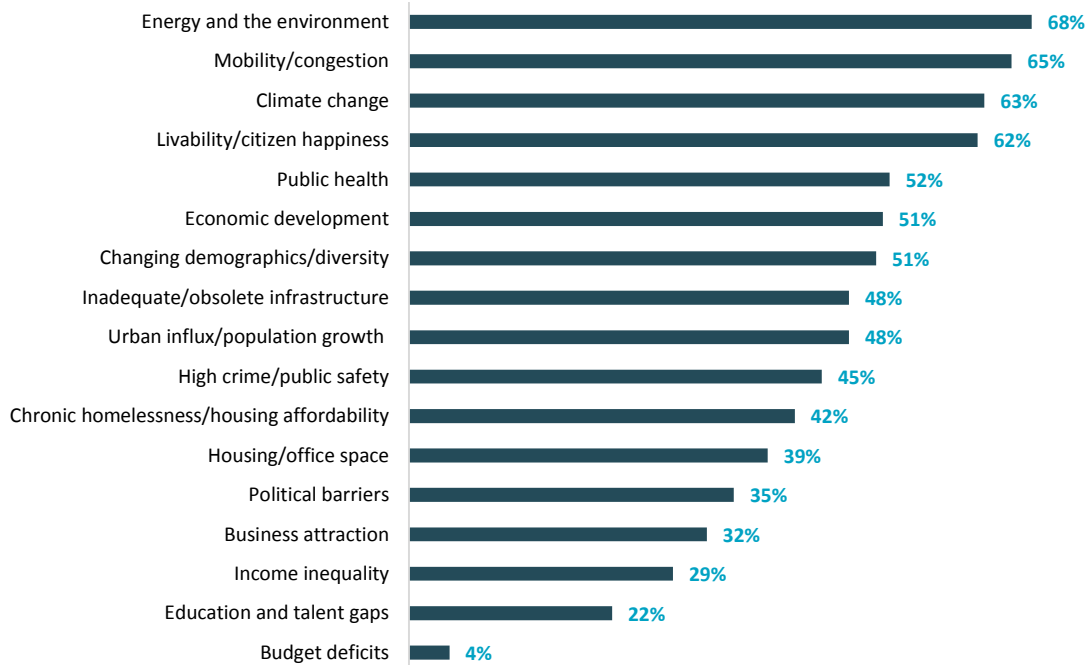The Business Case for
Smart Cities

Calls to Action

Cities require additional funding to meet growing challenges

Cities are currently using or planning to use smart city solutions to cope with a vast array of urban challenges. These range from environmental, public health and safety issues to chronic homelessness, income inequity, and educational gaps.

As a result, urban leaders need to be creative and resourceful in finding ways to fund their future.

Perhaps surprisingly, only a small handful are now addressing budget deficits through smart city initiatives, although user fees and new monetization techniques may help to fill budget gaps.

Main challenges cities are addressing through smart initiatives

Challenge	%
Energy and the environment	68%
Mobility/congestion	65%
Climate change	63%
Livability/citizen happiness	62%
Public health	52%
Economic development	51%
Changing demographics/diversity	51%
Inadequate/obsolete infrastructure	48%
Urban influx/population growth	48%
High crime/public safety	45%
Chronic homelessness/housing affordability	42%
Housing/office space	39%
Political barriers	35%
Business attraction	32%
Income inequality	29%
Education and talent gaps	22%
Budget deficits	4%

Q: Please indicate the main challenges that your city is addressing or planning to address through smart city initiatives. Please select all that apply.

Financing shifts ahead

To fund their smart city programs, cities are using a wide range of financing tools, and plan to expand their use of most over the next three years.

In the future, public-private partnerships will be the dominant financing technique, followed by concession financing, revenue share financing, and department budgets, which will all grow in use over current levels. One example of public-private partnerships in action is Cisco's $1 billion City Infrastructure Financing Acceleration Program.

While the use of philanthropic support will dip by 5% to 58% of cities, the reliance on state support will soar 58% to half of the cities surveyed. Federal support will jump 71% to 39% of cities. Many countries are now offering national or regional funding for smart city development. India's Smart City Mission and the US's Smart City Initiative are just two examples of such government programs.

Q: What mechanisms does your city currently use and which is your city planning to use to finance smart city initiatives in the next three years ?

How cities are now or planning to fund their smart city programs

	Now	Three years	% change
Philanthropic support	61%	58%	-5%
Public-private partnerships	60%	65%	8%
Department budgets	53%	59%	11%
Pay-for-success	53%	49%	-7%
Revenue share financing	52%	60%	14%
As a service financing	51%	58%	15%
Concession financing	49%	60%	21%
Consumption-based financing	47%	43%	-10%
State support	32%	50%	58%
User fees	28%	34%	21%
Sales and leaseback	27%	32%	22%
Franchise or shared revenue model	26%	34%	32%
Federal support	23%	39%	71%
Debt	21%	22%	7%

Becoming smarter: technology-enabled pillars

In addition to the foundational pillars, urban leaders should focus on five smart building blocks that will drive value to all urban stakeholders. While no two cities are the same, there are many urban issues—such as congestion, pollution, and crime—that can be addressed through digitally enabling these five pillars.

Smart mobility: fully integrated transportation options, including public and private services across all modes of transportation.

Smart environment: improved sustainability, energy use, and resource allocation through innovative solutions and local commitment.

Smart public safety: the use of advanced technology and other innovative solutions to prevent crime, respond to emergencies, and ensure public safety.

Smart public health: digitally-enabled devices and diagnostic tools, and remote medicine and treatment that can improve the quality of life for city dwellers.

Smart payment systems: the use of credit cards, mobile apps, and other digital payment methods that can enable frictionless and faster commercial transactions in cities.

Smart Mobility

For smart cities, the future of mobility is multi-modal transportation systems. Our study shows that smart cities are developing a wider array of smart transportation choices to meet the needs of residents from across generations, including:

Ride-sharing Although currently private-sector, ride-share technology can be adapted for public transport or combined with autonomous vehicles in the future.

Bike- and car-sharing Both reduce the need for car ownership; bike-sharing can speed travel, reduce congestion and pollution, and promote public health.

Smart transit systems These can speed transit times, reduce waiting, and ease congestion and pollution by alerting riders to bus and train arrival, and helping transport systems manage fleet deployment.

Real-time transit mobile apps These reduce wait times and increase user satisfaction by alerting riders to arrival times for public transit.

Smart traffic signals By adapting to real-time traffic flow, these save time and fuel for drivers, and ease congestion and pollution.

Smart parking By providing drivers with real-time locations for available parking spaces, this can reduce time spent searching, and as a result, pollution and congestion.

"Smart mobility is a significant opportunity for city governments because it offers multiple benefits—including time savings and emissions improvements—as well as giving a boost to the local economy."

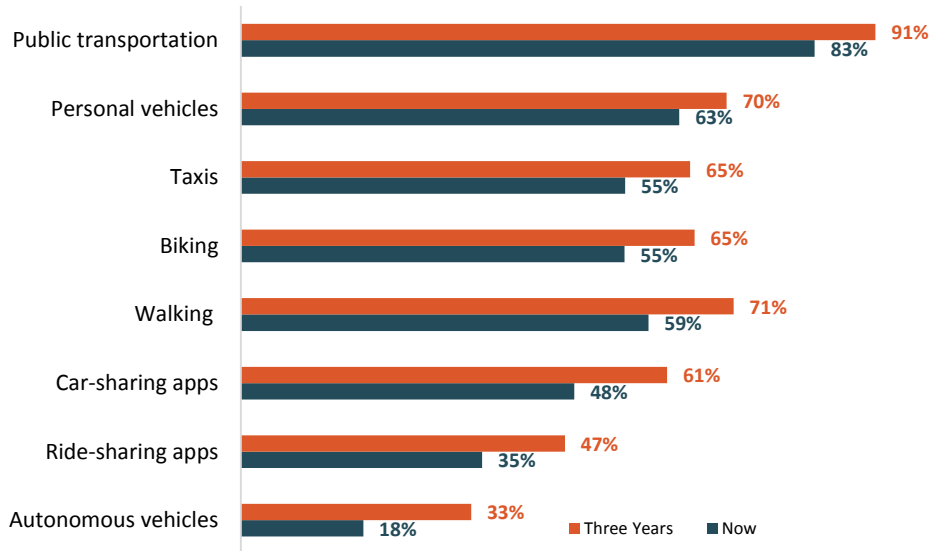-Mark Saunders, Director, Center of Excellence for Cities, Ferrovial Services

The future of mobility will be multi-modal

City government officials believe all modes of transportation will rise in importance in the future. Although they don't consider the development of autonomous vehicles very important today, they expect this mode to grow in importance over the next three years, followed by ride-sharing apps (+552%), and car-sharing apps (+371%).

The importance of different transport modes now and in three years

Mode	Three Years	Now
Public transportation	91%	83%
Personal vehicles	70%	63%
Taxis	65%	55%
Biking	65%	55%
Walking	71%	59%
Car-sharing apps	61%	48%
Ride-sharing apps	47%	35%
Autonomous vehicles	33%	18%

■ Three Years ■ Now

Q: How important are the following modes of transportation in your city?

How ride-sharing is changing mobility

Most citizens in our 11 proxy cities now rely chiefly on public transportation, but they also use ride-sharing apps regularly. Nearly a third say that ride-sharing apps have decreased their use of public transportation; in Chicago, a larger percentage (31% vs 25%) now use ride-sharing than public transportation. Moreover, 36.8% across cities said that ride-sharing has reduced their car usage—and more than 9% have opted to forgo car ownership as a result.

The impact of ride-sharing apps

Response	%
I still use my personal vehicle, but I use it less.	36.8%
I use public transportation less.	32.6%
I use taxi cabs less.	21.9%
No impact	14.5%
I stopped using taxi cabs.	9.8%
I stopped using public transportation.	9.5%
I sold my car or decided not to purchase a car.	9.3%
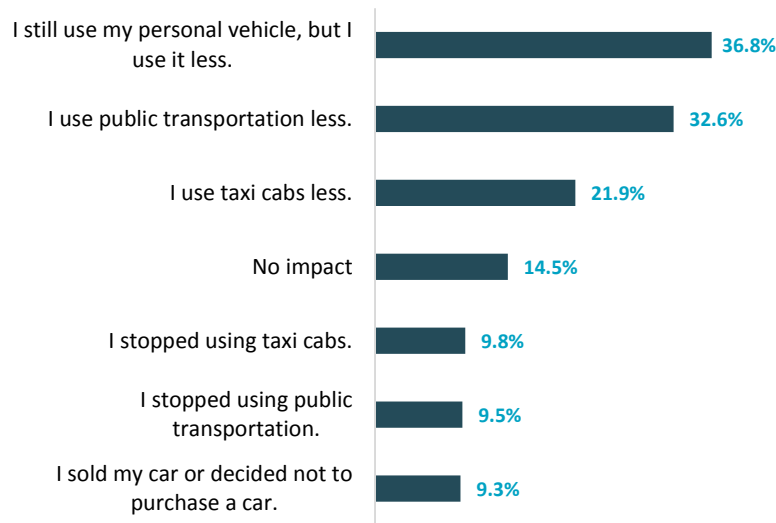
Q: How have ride-sharing apps changed your behavior?

Frequency of use of modes of transportation

	% Usage		Trips per week	
	Public Transportation	Ride-sharing app	Public transportation	Ride-sharing app
Athens	60%	30%	8.7	1.5
Chicago	25%	31%	6.8	1.8
Copenhagen	46%	34%	8.3	1.6
Dubai	59%	46%	8.0	2.3
Greater Belo Horizonte	60%	43%	6.7	2.3
Lagos	70%	36%	9.0	1.7
Madrid	48%	27%	8.1	1.8
Moscow	65%	30%	7.6	1.7
New Delhi	57%	29%	9.1	3.5
Shanghai	60%	35%	7.8	2.6
Tokyo	54%	34%	7.9	1.4

Q: How often do you use the following modes of transportation?

Urbanites want investment in a wider array of transportation modes

Over half of the people living in cities believe that their local governments should invest in a wider mix of smart transportation solutions, from using data to improve transportation routes and dealing swiftly to traffic problems, to offering more travel options and universal payment accounts covering all local modes of transportation.

Younger generations, which represent the future for urban centers, have a greater desire for smarter transportation options. For example, 53% of millennials would like cities to use their data to personalize travel suggestions vs 39% of boomers. A similar divide can be seen on providing more travel options and planning for autonomous vehicles.

Q: In your view, how much should your city invest in the following initiatives to improve mobility and transportation in your city?

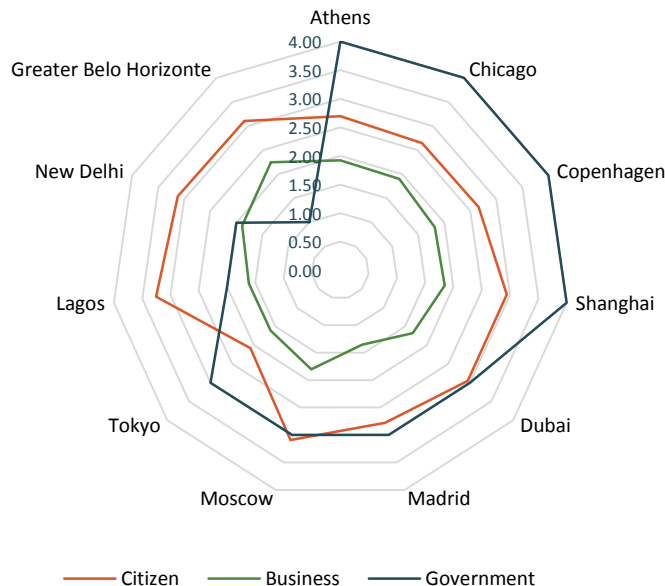| Where residents think cities should make transportation investments		Age		
	Total	**18-37**	**38-53**	**54+**
Using data to improve transportation routes	60%	62%	56%	63%
Improving the speed/reliability of public transportation	59%	60%	55%	59%
Using real-time data to respond quickly to traffic issues	59%	60%	55%	61%
Offering payment accounts for all transportation modes	57%	58%	57%	52%
Sharing data with public on traffic, roads, etc	57%	60%	52%	54%
Providing more travel options (bikes, ferries, etc)	57%	61%	52%	41%
Providing electric vehicle charging stations	55%	57%	51%	56%
Using my data to personalize travel suggestions	49%	53%	42%	39%
Planning for autonomous vehicles	49%	52%	45%	37%
Exploring drones/driverless trucks for moving goods	42%	44%	38%	35%

Governments in poorer cities not focusing enough on congestion

In poorer developing cities, such as Lagos, New Delhi, and Greater Belo Horizonte, government priorities on improving mobility and reducing congestion are often considerably behind where residents and businesses believe they should be.

Conversely, in richer, more developed cities, such as Chicago, Copenhagen, and Shanghai, governments are often more focused on mobility than their citizens and businesses expect them to be.

Q: How important are the following modes of transportation in your city?

Current mobility priorities of city governments vs the level stakeholders want to see

Legend: Citizen, Business, Government

Smart traffic management reduces congestion
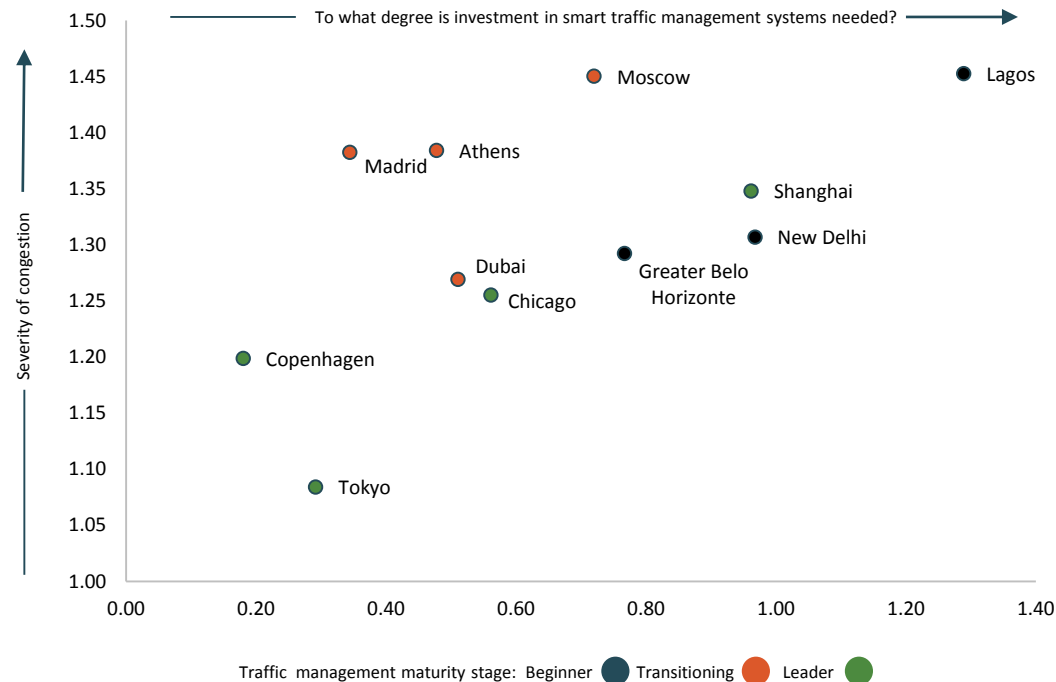
Citizens' sentiment on congestion severity and investment for traffic management

Leaders in traffic management use innovative technologies like smart traffic signals, sensors, predicative analytics, and cashless tolling. As they become leaders, their perceived severity of congestion lessens.

We used survey data to calculate congestion levels in our 11 proxy cities and asked citizens how strong the need is for their city government to invest more in smart traffic management technologies to alleviate congestion.

There is a clear correlation between congestion levels and the perceived importance of more investment. Also, cities in the later stages of traffic management maturity appear to have somewhat less congestion when compared with beginning cities.

To what degree is investment in smart traffic management systems needed?

Severity of congestion

1.50
1.45 — Moscow   Lagos
1.40
1.35   Shanghai
       Athens
1.30   New Delhi
Madrid
1.25   Dubai   Greater Belo
          Chicago   Horizonte
1.20 Copenhagen
1.15
1.10
1.05 Tokyo
1.00
0.00 0.20 0.40 0.60 0.80 1.00 1.20 1.40

Traffic management maturity stage: Beginner ● Transitioning ● Leader ●

Q: To what degree is investment in smart traffic management needed in your city (x-axis)?

Smart traffic signals reduce travel and pollution

A study by Carnegie Mellon University found that smart traffic signals could reduce overall travel time up to 25%, creating benefits not only reserved for those commuting, but for the city as a whole. In addition to saving time, fuel, and frustration for drivers, congestion reduction can cut pollution, increase productivity, and increase citizen satisfaction.

Cities that have not yet implemented smart traffic signals can potentially gain the largest per capita time savings. Potential savings is lower for more mature cities, which have already made progress on smart traffic signals.

Total per capita personal time savings, in hours, from traffic reduction by maturity level

9.7

4.7

2.0
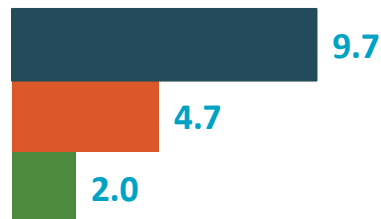
Average annual per capita fuel savings

3.3 gallons

1.9 gallons

0.6 gallons

Traffic management maturity stage: Beginner ● Transitioning ● Leader ●

Mobile apps for transit data reduce wait times and increase satisfaction

Researchers from the City College of New York and Georgia Institute of Technology found that, in addition to decreasing actual and perceived waiting time, transit mobile applications can also increase ridership. It is estimated that a transit mobile application can increase ridership by an average of 6.92 trips per capita per year for beginning cities. More mature cities that already use some form of this technology can capture additional benefits through improvements in usage, accuracy, and functionality.

Increased ridership: annual trips per capita per year

6.92

4.83

3.95

Time savings: travel hours saved per capita per year

10.03

7.01

5.72

Public transportation maturity stage: Beginner ● Transitioning ● Leader ●

Smart Environment

The environment and climate change are two of the top urban challenges that cities hope to correct through the use of smart technologies.

But despite the recognition of the environment as a thorny issue by government officials, only 20% of all 136 cities surveyed rate themselves as advanced in waste management. For managing air quality, the percentage was slightly lower (19%).

These ecological issues are top of mind for citizens and business leaders, who would like their cities to raise their investments in environmental solutions. In fact, both citizens and businesses said they would be willing to pay more for environmental improvements.

Where stakeholders want cities to invest more	Citizens	Businesses
Providing data to make businesses/consumers more aware of energy use	56%	49%
Installing smart grids that use embedded sensors to manage waters, gas, and electric services	55%	46%
Installing environmental sensors to provide continuous monitoring of air quality, pollution, etc.	54%	43%
Improving coordination of power generation and power demand	54%	36%
Using predictive maintenance planning to focus on key environmental areas	54%	47%
Offering incentives for installing responsive devices and appliances	52%	44%
Focusing on distributed generation from renewable sources and micro-grids	50%	27%

How citizens view environmental issues

Our research shows that citizens in emerging-market cities, such as Greater Belo Horizonte, Lagos, New Delhi, and Shanghai, are more likely to see environmental issues, such as air pollution, cleanliness, and sewage disposal as a concern. One emerging-market city bucking that trend is Dubai, which in 2006, had one of the worst ecological footprints per capita in the world. By investing in smart environmental solutions, such as the world's largest solar park and a hyperloop to support mass transit, Dubai is now an environmental success story. Of course, most emerging cities do not have Dubai's deep pockets.

	All cities	Athens	Chicago	Copenhagen	Dubai	Greater BH	Lagos	Madrid	Moscow	New Delhi	Shanghai	Tokyo
Air pollution is a problem in my city.	61%	50%	58%	33%	40%	71%	73%	66%	64%	89%	77%	39%
Ensuring environmental compliance is important in my city.	58%	47%	52%	55%	53%	53%	63%	62%	51%	78%	79%	46%
I would pay more to improve the environment and infrastructure.	58%	51%	48%	47%	56%	53%	79%	59%	48%	86%	72%	37%
Environment is a major concern.	57%	46%	55%	50%	42%	53%	70%	59%	59%	81%	71%	39%
Quality public parks are available.	57%	37%	68%	55%	58%	49%	30%	64%	64%	75%	78%	44%
Energy reduction is important.	55%	42%	52%	43%	46%	56%	63%	60%	43%	76%	73%	42%
Street cleanliness is a problem.	54%	52%	50%	39%	25%	65%	74%	55%	48%	81%	63%	40%
I am satisfied with the measures my city takes to recycle.	50%	32%	57%	60%	60%	41%	36%	55%	27%	72%	66%	44%
Sewage disposal is a local problem.	46%	35%	40%	29%	35%	63%	54%	40%	46%	76%	54%	23%
Water quality is a problem in my city.	45%	30%	54%	50%	53%	33%	17%	48%	44%	73%	65%	27%

Q: Please indicate how strongly you agree or disagree with the following statements. (Displaying strongly agree or agree.)

The environment is a top challenge for most cities

Of the many problems facing cities—from crime and homelessness to education and public health—energy and the environment is the number one challenge (out of 17 issues), according to our survey of 136 government leaders. Climate change, a related issue, was ranked third.
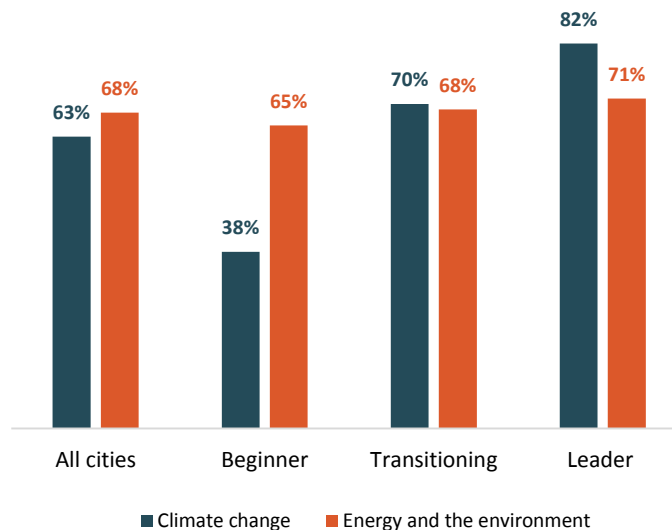
Energy and the environment is a high priority for all cities, regardless of their maturity level. However, climate change becomes a bigger challenge for cities as they mature and work through more basic environmental and energy management issues.

| Top 10 city challenges ranked by city leaders	
Energy and the environment	68%
Mobility/congestion	65%
Climate change	63%
Livability/citizen happiness	62%
Public health	52%
Economic development	52%
Changing demographics and diversity	51%
Inadequate/obsolete infrastructure	48%
Urban influx/population growth	48%
High crime/public safety	45%

Importance of environmental challenges by maturity

	Climate change	Energy and the environment
All cities	63%	68%
Beginner	38%	65%
Transitioning	70%	68%
Leader	82%	71%

■ Climate change   ■ Energy and the environment

Q: Please indicate the main challenges that your city is addressing or planning to address through smart city initiatives.

Smart grid integrated volt control's potential economic benefits

Integrated volt control capabilities from smart utility grids can help utilities more efficiently manage voltage on their distribution lines, allowing utilities to reduce the total energy used by citizens without any sacrifice in service or quality. A study by the Smart Grid Consumer Collaborative found that this technology can reduce voltage needed during peak demand hours by 3.25%, resulting in an overall total electricity reduction of 2.7% on average per year. Our model estimates that cities in the beginning stages of smart energy maturity would be able to realize a usage reduction per capita of $29.86 per year and a reduction in CO_2 emissions of 223 pounds per person per year.

Total per capita energy savings by smart energy maturity level

$29.86

$21.86

$9.16
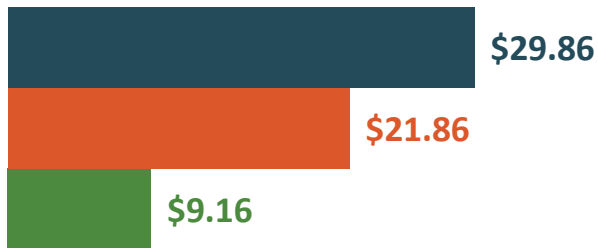
CO_2 emissions reduction per capita by maturity

223 lbs.

166 lbs.

70 lbs.

Energy management maturity stage: Beginner ⬤ Transitioning ⬤ Leader ⬤

Citizens in more polluted cities see a greater need for smart investment

As might be expected, citizens in more polluted cities, such as Lagos, Shanghai, and New Delhi, where citizens rated it as a more severe problem, see a greater need for additional investment in smart environmental technologies such as pollution detection sensors.

Citizens' sentiment on severity of pollution and degree of investment for pollution reduction
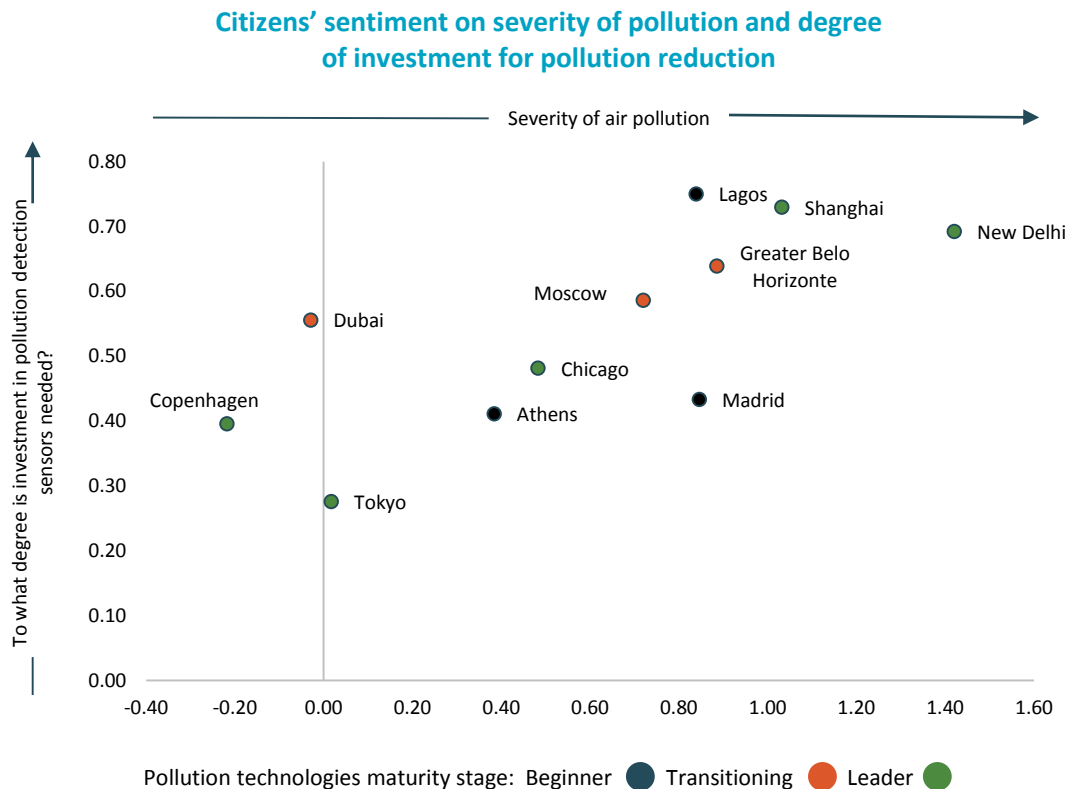
Q: To what degree do you think air pollution is an issue in your city (x-axis)? To what degree is investment in pollution detection needed in your city (y-axis)?
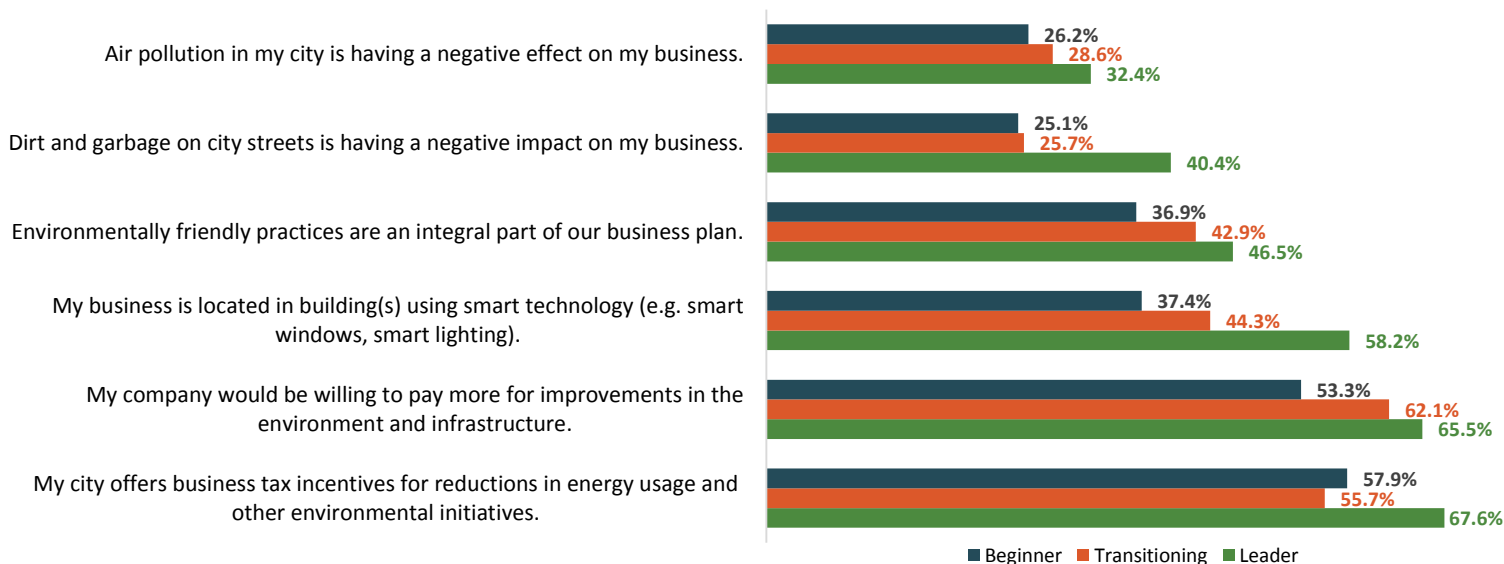
Pollution technologies maturity stage: Beginner ● Transitioning ● Leader ●

Businesses in leader cities have strong ecological views

Businesses in the most mature smart cities have stronger views on all environmental issues than those in less advanced cities. They are more willing to pay for environmental improvements, and their cities are more likely to offer environmental tax incentives. Oddly, they are more likely to say pollution and refuse are a problem, even though generally these are a greater issue in less advanced cities. However, it may be that businesses in leader cities have higher environmental expectations.

Businesses' sentiment on their city's environmental issues

Air pollution in my city is having a negative effect on my business.
- Beginner: 26.2%
- Transitioning: 28.6%
- Leader: 32.4%

Dirt and garbage on city streets is having a negative impact on my business.
- Beginner: 25.1%
- Transitioning: 25.7%
- Leader: 40.4%

Environmentally friendly practices are an integral part of our business plan.
- Beginner: 36.9%
- Transitioning: 42.9%
- Leader: 46.5%

My business is located in building(s) using smart technology (e.g. smart windows, smart lighting).
- Beginner: 37.4%
- Transitioning: 44.3%
- Leader: 58.2%

My company would be willing to pay more for improvements in the environment and infrastructure.
- Beginner: 53.3%
- Transitioning: 62.1%
- Leader: 65.5%

My city offers business tax incentives for reductions in energy usage and other environmental initiatives.
- Beginner: 57.9%
- Transitioning: 55.7%
- Leader: 67.6%

■ Beginner ■ Transitioning ■ Leader

Q: Please indicate how strongly you agree or disagree with the following statements. (Displaying strongly agree or agree.)

Smart Public Safety

Ensuring public safety is an essential role for every city government. In fact, 45% of 136 cities surveyed see high crime and public safety as one of their main challenges, which they hope to alleviate through the use of smart technologies. This view about crime is even more pronounced in Asian cities (68%) and in large cities with populations over 10 million (53%). Cities are exploring an array of smart technologies to combat crime, including:

• Big data and AI for real-time facial recognition, license plate scanning, crowd-sourcing apps, as well as predictive policing tools to anticipate where and when crimes may occur.

• Drones for search and rescue missions, viewing hostage situations, monitoring fires and automobile accidents, and even tracking down escaped criminals.

• Acoustic sensors to alert police departments when a gunshot is fired— currently used by over 90 cities in the US.

• Body cameras for police to keep both officers and the public accountable during interactions, and to photograph evidence or record interviews.

• Smart street lighting to detecting gunshots and show whether pedestrians and vehicles are approaching.

"We believe that precision policing represents the next phase of the policing revolution. It draws on previous innovations, like CompStat (a data-based tool), and criminological advances, like quality-of-life policing, but goes beyond them. We believe that it can make any city, town, or neighborhood a safer—and fairer—place."

-William J. Bratton is the former police commissioner of New York City, where crime rates have fallen to their lowest level since the 1950s

Stakeholder views differ on the level of crime in cities

While perceptions and actual levels of crime do not always align, both are important for city governments when assessing the public safety concerns of their citizens.

According to our survey, the most crime-ridden among our 11 proxy cities are the poorest: Greater Belo Horizonte, Lagos, and New Delhi. Over half of citizens in Greater Belo Horizonte said crime was a major issue for their city, but government officials did not cite it as a main challenge. Similarly, while more than 60% of citizens in Lagos and New Delhi do not see crime as a top concern, their government does. Meanwhile, in Chicago, where reported crime rates are relatively low, over half of citizens consider it a key issue and government agrees.

Oddly, business perceptions are not largely consistent: while crime was a top concern for over a quarter of businesses in high-crime New Delhi, that was also the case for Tokyo and Shanghai, which have the two lowest reported crime rates.

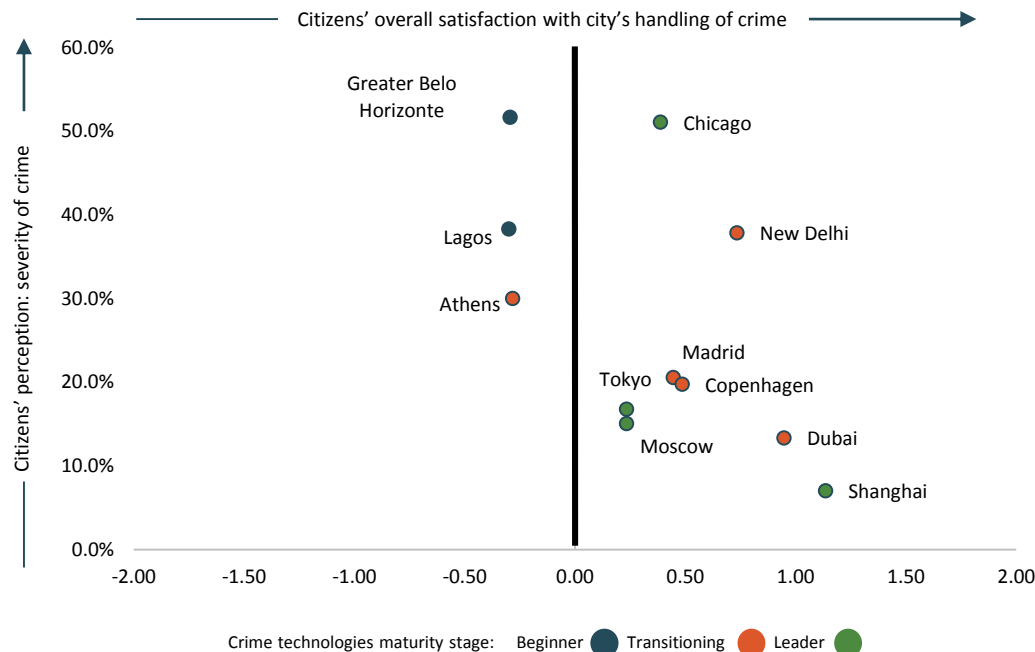|	Is public safety one of the main challenges being addressed through smart technologies?	Is public safety one of the top three issues facing your city?		Have you or someone in your household been a crime victim in the last three years?	
	Government	**Citizens**	**Business**	**Violent Crime**	**Property Crime**
Greater BH		52%	25%	31%	28%
Chicago	Yes	51%	21%	16%	17%
Lagos	Yes	38%	15%	26%	32%
New Delhi	Yes	38%	29%	28%	23%
Athens		30%	12%	18%	17%
Madrid	Yes	21%	17%	19%	19%
Copenhagen		20%	14%	26%	22%
Tokyo	Yes	17%	29%	10%	13%
Moscow		15%	20%	13%	15%
Dubai		13%	23%	24%	16%
Shanghai	Yes	7%	26%	5%	7%

Crime appears lower to citizens in cities using smart crime technologies

Citizens in cities using smart crime technologies are generally satisfied with the handling of crime, which they believe is less severe. We asked city governments to describe their level of maturity in usage of smart crime technologies, such as predictive policing, gunshot detection, body cameras for police officers, and license plate scanning. While citizens in more cities with more mature policing tools, such as Shanghai, Tokyo, and Moscow, tended to think crime was lower, this was not the case for Chicago. More than half the citizens in Chicago believe that crime is one of the three biggest issues facing their city today.

However, citizens in Chicago were generally satisfied with the city's handling of crime. By contrast, those in Greater Belo Horizonte and Lagos—cities just starting to use smart crime technology—were generally dissatisfied.

Effectiveness of smart policing tools

Citizens' overall satisfaction with city's handling of crime →

Citizens' perception: severity of crime

Data points: Greater Belo Horizonte (≈51%, Transitioning), Chicago (≈50%, Leader), Lagos (≈38%, Transitioning), New Delhi (≈38%, Leader), Athens (≈30%, Leader), Madrid (≈20%, Leader), Tokyo (≈18%, Leader), Copenhagen (≈19%, Leader), Moscow (≈15%, Leader), Dubai (≈13%, Leader), Shanghai (≈8%, Leader)

X-axis: -2.00 to 2.00; Y-axis: 0.0% to 60.0%

Crime technologies maturity stage: Beginner / Transitioning / Leader

Q: How satisfied are you with your city's overall handling of crime (x-axis)? Do you think crime is one of the top three issues in your city (y-axis)?

75

Predictive policing reduces crime 5-10%

A recent study by researchers at UCLA found that predictive policing reduces both violent and property crimes. Our model shows that predictive policing reduces violent crimes by about 5% and property crimes by about 10% across all 136 benchmarked cities. On average, this reduction in crimes leads to a savings of $420.33 per capita throughout all cities. Cities just starting to embrace smart crime technologies will realize larger benefits than those cities that are more mature in their use. We estimate that beginning cities could cut overall crime costs by $529.60 per capita, including tangible costs to the victim, pain and suffering, and costs to the criminal justice system.

Total per capita crime reduction savings by smart crime maturity level
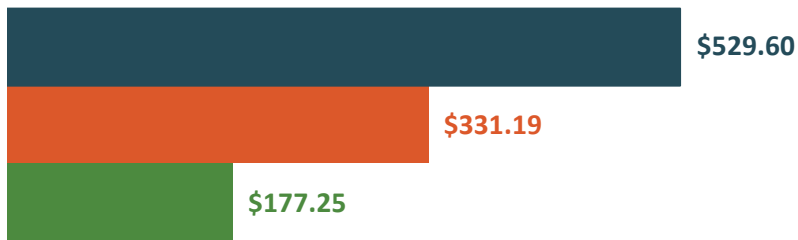
$529.60

$331.19

$177.25

Total crime reduction
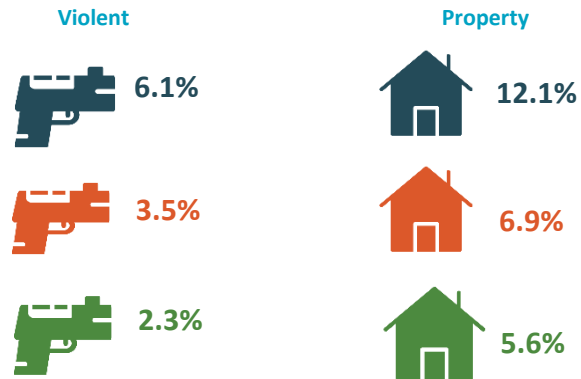
Violent

6.1%

3.5%

2.3%

Property

12.1%

6.9%

5.6%

Crime technologies maturity stage: Beginner ● Transitioning ● Leader ●

Smart Public Health

While public health is often considered a national or private-sector issue, city governments have a responsibility to promote and ensure a healthy living environment. According to the World Health Organization (WHO), cities should create a health-supportive environment, achieve a high quality of life, provide basic sanitation and hygiene needs, and supply access to superior healthcare.

Most city officials agree in our survey agree. About 62% of 136 cities surveyed ranked smart public health as a top priority, one that rises from 32% for smart city beginners to 82% for leaders. It is a much higher priority in advanced markets (70%) than emerging markets (47%). Cities in Western Europe (76%), Eastern Europe (70%), and North America (64%) particularly rate public health as a high priority.

To improve the health of their citizens, smart cities are working with the healthcare and academic communities to promote the use of latest technologies, such as wearable sensors that monitor an individual's physical activity and health, telemedicine that allows doctors to treat patients remotely, and street light sensors that track air quality and pollution.

Spotlight: Copenhagen

Copenhagen is considered one of the healthiest cities in the world according to the World Health Organization. The city promotes health in everyday life by making it attractive to cycle, creating abundant green space, finding the right work-life balance, ensuring air and water quality, and encouraging healthy eating and quit-smoking programs. In the words of Ninna Thomsen, Copenhagen's mayor for health and care, "Health is not a goal in itself, but is a means to enjoying life."

Copenhagen is also using advanced smart technology to improve the health of its residents. For example, our research found that 90% of citizens use or have access to communication with doctors through mobile apps. And 83% are able to have their medical records easily transferred among doctors.

The use of smart health technologies from the citizen's perspective

Our economists created a ranking of the local use of smart health technologies, based on the responses of citizens living in 11 proxy cities. These rankings correlated the availability of health-related monitoring with the technological sophistication of local hospitals.

Our analysis showed Shanghai, New Delhi, and Dubai the furthest ahead in the eyes of residents, followed by Chicago, Madrid, and Copenhagen. Most of the cities that were behind in this measure are those starting their smart city journey, including Athens, Lagos, and Greater Belo Horizonte.

Our study also found that cities in emerging markets are more likely to see public health as a major challenge requiring smart solutions (58%), vs advanced market cities (50%). This may reflect the poorer healthcare conditions in emerging markets and the need for more innovative solutions.

Citizens' perspective on their city's hospitals
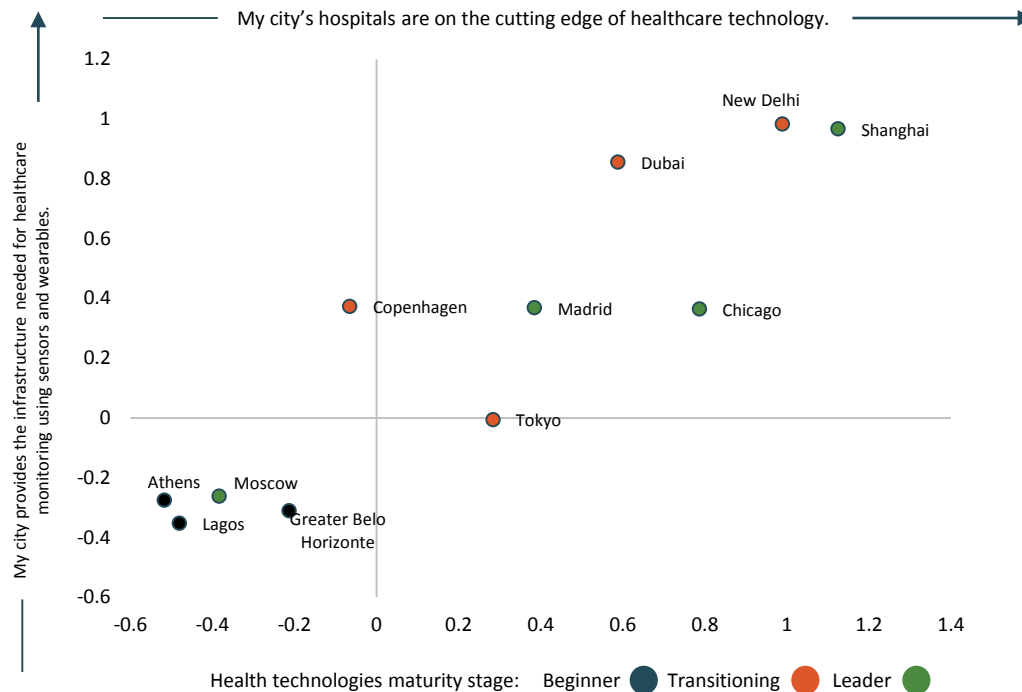
Q: To what degree to you agree with the statements: My city's hospitals are on the cutting edge of technology (x-axis), My city provides the infrastructure needed for smart health technologies (y-axis)?
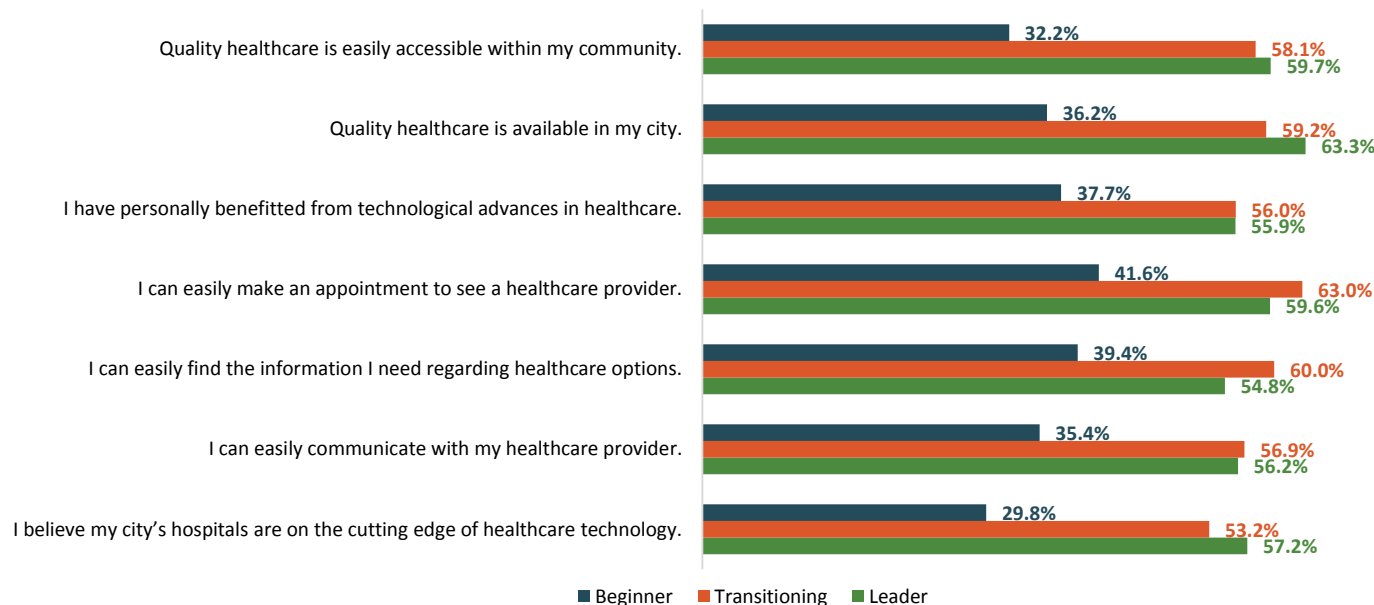
Citizens see public health challenges in beginner cities

Smart city beginners are facing many more healthcare challenges than cities in later stages of maturity. For example, beginners have half the access to quality healthcare than transitioning and leader cities. Less than 30% of beginners have hospitals on the cutting edge of technology vs more than half of transitioning and leader cities.

Citizens' perspective on the accessibility and quality of their city's healthcare

Quality healthcare is easily accessible within my community.
- Beginner: 32.2%
- Transitioning: 58.1%
- Leader: 59.7%

Quality healthcare is available in my city.
- Beginner: 36.2%
- Transitioning: 59.2%
- Leader: 63.3%

I have personally benefitted from technological advances in healthcare.
- Beginner: 37.7%
- Transitioning: 56.0%
- Leader: 55.9%

I can easily make an appointment to see a healthcare provider.
- Beginner: 41.6%
- Transitioning: 63.0%
- Leader: 59.6%

I can easily find the information I need regarding healthcare options.
- Beginner: 39.4%
- Transitioning: 60.0%
- Leader: 54.8%

I can easily communicate with my healthcare provider.
- Beginner: 35.4%
- Transitioning: 56.9%
- Leader: 56.2%

I believe my city's hospitals are on the cutting edge of healthcare technology.
- Beginner: 29.8%
- Transitioning: 53.2%
- Leader: 57.2%

■ Beginner ■ Transitioning ■ Leader

Q: Please indicate your level of agreement with the following statements about health care. Select one in each row (agree or strongly agree are shown).
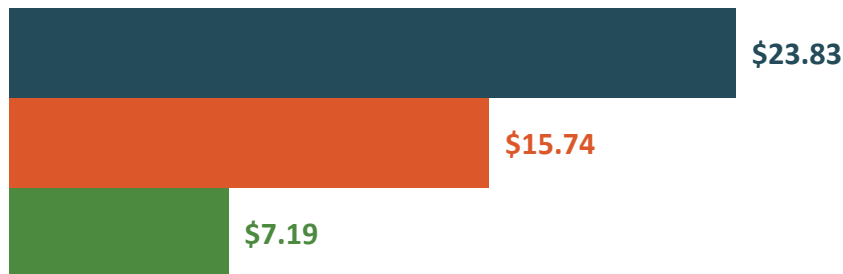
Introduction

Research Methodology

The Path to a Smart City Future

The 10 Pillars of Smart City Success

The Business Case for Smart Cities

Calls to Action

Telemedicine's potential economic benefits

Many countries are embracing telemedicine to manage chronic, non-infectious diseases such as COPD (chronic obstructive pulmonary disease), which is expected to be the world's third leading cause of death by 2030. It allows patients are able to manage their care remotely, without physically visiting their doctors, and practitioners are able to more easily monitor their patients' symptoms. A recent study prepared for the auditor general for Scotland found that using telemedicine for citizens with moderate to severe COPD can reduce costs by approximately 21%. We estimate that the adoption of telemedicine for COPD patients would result in an average cost savings of $23.83 per capita in cities not currently using any type of telemedicine; cities already using telemedicine to some extent can still capture additional benefits through expansion and improvements.

Per capita healthcare savings from treating COPD through telemedicine

$23.83

$15.74

$7.19

Health technologies maturity stage: Beginner ● Transitioning ● Leader ●

Smart Payments

Digital payment systems, which eliminate the need for cash, enable stakeholders to maximize the value from smart city solutions. The potential benefits associated with moving toward smarter payments will vary by a city's maturity across the other pillars, as well as the level of digital payment usage by businesses, consumers, and the government.

Smart payments allow consumers to reduce the need to carry cash for everyday transactions, such as cutting the time spent visiting ATMs and banks, paying bills, balancing checkbooks, boarding public transit vehicles, and paying tolls. E-payments can help the city's poor, who can find using cash more time consuming, expensive, and vulnerable to crime.

More intensive use of smart payments will help businesses reduce business costs. Using and accepting cash (and checks) is expensive for businesses and merchants. When businesses handle cash and paper checks, they suffer losses through employee theft, inaccurate cash handling, check fraud, and expensive procedures required to minimize these losses.

The use of smart payments can have significant benefits for government. Cash helps fuel the informal economy, which is untaxed and untraceable. This generates costs for government in the form of lost tax revenue. The use of e-payments by government helps to improve transparency and enables government to strengthen financial controls, minimize fraud, and increase revenue. The processing and handling of cash also generates significant costs for transit agencies and toll road authorities.

"It is time we acknowledged the cash paradox. While cash may be considered the poor man's best friend, it also places a disproportionate burden on the poor."

-Bhaskar Chakravorti, Senior Associate Dean
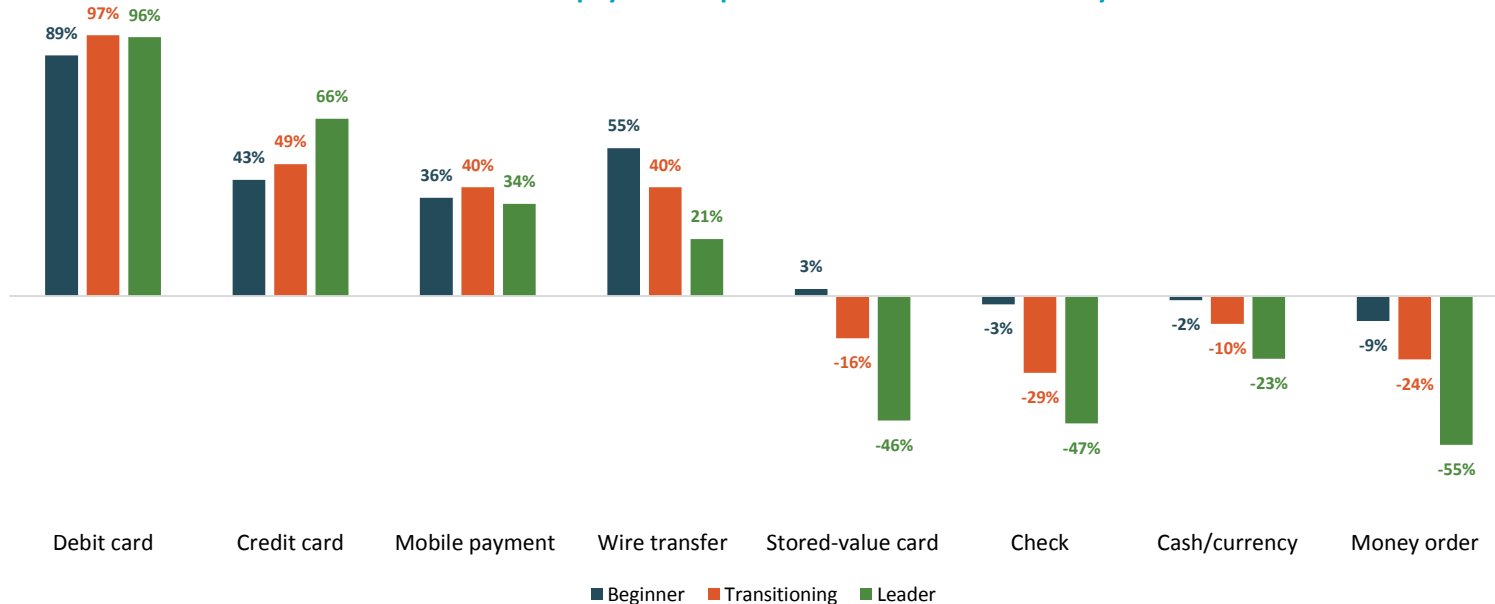The Fletcher School, Tufts University

Business see rise in cashless and fall in cash payments over three years

Businesses across cities expect their customers to expand their use of digital payments, including debit cards, credit cards, mobile payments, and wire transfers, while decreasing their use of physical money. The largest drops in cash usage will be in smart leader cities, but the growth of digital payment methods will happen in cities across smart city stages.

Businesses' payment expectations over the next three years

Debit card: Beginner 89%, Transitioning 97%, Leader 96%
Credit card: Beginner 43%, Transitioning 49%, Leader 66%
Mobile payment: Beginner 36%, Transitioning 40%, Leader 34%
Wire transfer: Beginner 55%, Transitioning 40%, Leader 21%
Stored-value card: Beginner 3%, Transitioning -16%, Leader -46%
Check: Beginner -3%, Transitioning -29%, Leader -47%
Cash/currency: Beginner -2%, Transitioning -10%, Leader -23%
Money order: Beginner -9%, Transitioning -24%, Leader -55%

■ Beginner ■ Transitioning ■ Leader

Q: Over the next three years, how do you expect the usage of various payment methods by your customers to change? (Shows percent rise or fall.)
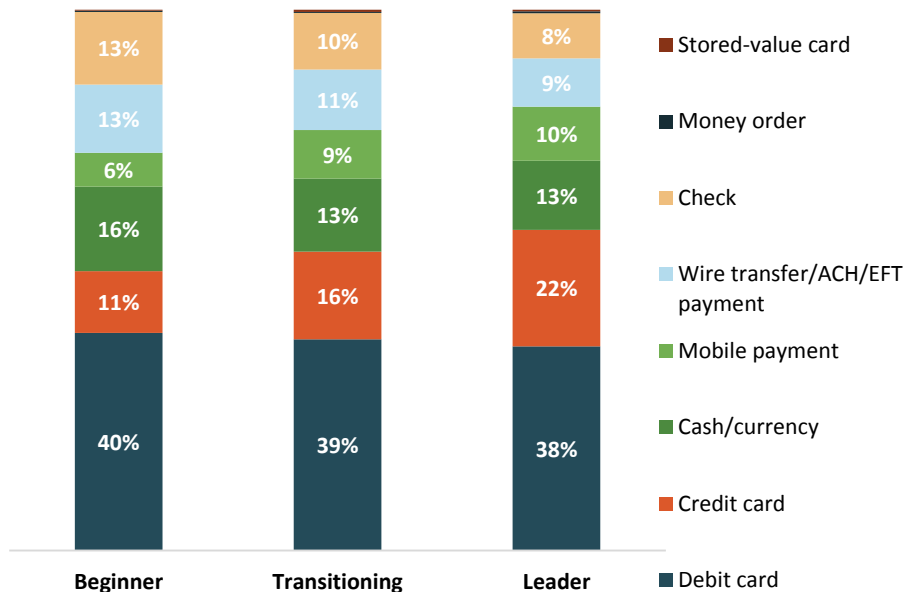
Consumers are eschewing cash

According to the businesses we surveyed in the 11 proxy cities, digital payments are already the dominant payment method. About 74% of monthly revenue comes through digital payments. The percentages are even higher for Shanghai (80%), Dubai (78%), and New Delhi (77%). Our research shows the highest priority for smart payments are set by city government in New Delhi and Chicago, followed by Shanghai, Tokyo, and Madrid.

Many establishments in Shanghai and other Chinese cities no longer accept cash. Smartphone payments, using the apps WeChat or Alipay, are becoming common forms of payments. In fact, mobile payments hit $5.5 trillion in urban Chinese cities in 2016, which is approximately 50 times the size of America's mobile payment market.

Q: In a given month, what percentage of your company's revenue typically comes through each of the following payment instruments?

Percentage of business revenue based on payment type by maturity level

	Beginner	Transitioning	Leader
Check	13%	10%	8%
Wire transfer/ACH/EFT	13%	11%	9%
Mobile payment	6%	9%	10%
Cash/currency	16%	13%	13%
Credit card	11%	16%	22%
Debit card	40%	39%	38%

Legend:
- Stored-value card
- Money order
- Check
- Wire transfer/ACH/EFT payment
- Mobile payment
- Cash/currency
- Credit card
- Debit card

Payment efficiency cost savings

According to our survey, nearly a third of cities are in the beginning stages of using smarter payments and another 43% are in the transitioning phase of using smarter payments. Our economic analysis found that cities in the beginning stages of smarter payment usage can see cost savings of 0.17% of GDP, or $144 per citizen; transitioning cities can unlock savings of 0.12% of GDP, or $140 per citizen; and leader cities can realize additional cost savings of 0.09% of GDP, or $126 per citizen.

Smart payment maturity

Beginner 33%
Transitioning 43%
Leader 24%
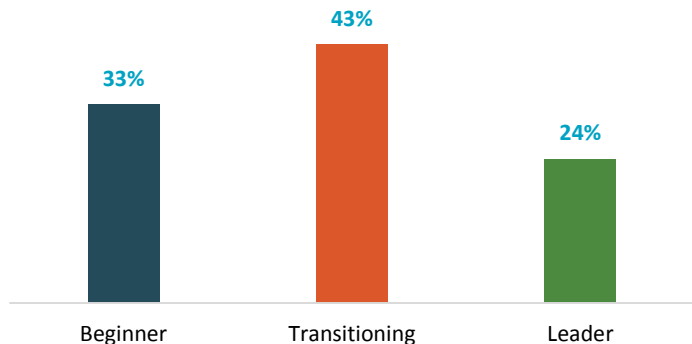
Average payment efficiency cost savings by maturity

$144/citizen   0.17% of GDP

$140/citizen   0.12% of GDP

$126/citizen   0.09% of GDP

Beginner ● Transitioning ● Leader ●

Q: Which stage best describes your city's level of maturity for smart payments?

Reduction in the shadow economy

The informal economy is comprised of two main components – (1) underground purchases that are undertaken to avoid taxation and (2) illegal activities, such as drug dealing, prostitution, and corruption. We estimate that in cities that are beginners in terms of smart payment usage, the average size of the shadow economy is 25% of GDP, in transitioning cities it is 13% of GDP, and in smart payment leader cities it is 10% of GDP.

Our economic analysis found that increases in smart payment maturity in beginner cities can reduce the size of shadow economy by an average of $5.3 billion per city, which is equal to 5.6% of GDP. In transitioning cities, the average reduction is $2.9 billion per city (1.7% of GDP) and in leader cities, the average reduction is $2.6 billion per city (0.9% of GDP).

Shadow economy as percent of GDP

- Beginner: 25%
- Transitioning: 13%
- Leader: 10%
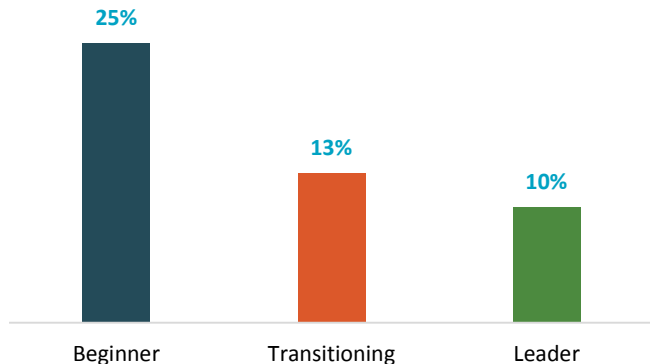
Average shadow economy reduction by maturity

	$5.3 billion	5.6% of GDP
	$2.9 billion	1.7% of GDP
	$2.6 billion	0.09% of GDP

Beginner ● Transitioning ● Leader ●

The Business Case for Smart Cities

"The smartest cities will provide rich and diverse solutions to meet the growing demands of increasingly mobile city dwellers. A winning combination will see investments in systems that enable smart cities to combine great urban experiences with more efficient and sustainable management of their assets and scarce resources."
- Mike Gedye, Executive Director, CBRE

Smarter cities will reap major benefits for all stakeholders

As cities advance along the smarter city maturity curve, they are better able to reap the benefits of investments in new technologies and systems. With a sound governance structure, sufficient financing and talented workers, smarter cities are able to capitalize on investments in smart innovation to generate new revenue streams and cost efficiencies. At the same time, smarter cities increase economic activity and livability for citizens and businesses.

These investments trigger a virtuous cycle of economic growth by generating capital for new smart city investments, as well as an improved ability to attract businesses, residents, tourists, students, and talent. While cities see livability improvements as the main initial benefits from smart city investments, in three years, they expect economic and financial benefits to grow materially as the virtuous cycle gains momentum.
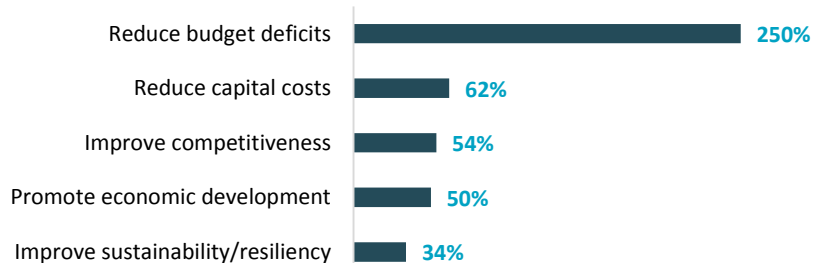
In the end, successful cities will morph into digitally-enabled hotbeds of innovation that will be a magnet for future talent, drive performance, and improve the human condition. Those cities that fail to keep up run risk falling even further behind the competition for capital, talent, and economic growth.

Q: What are the benefits that your city is gaining from its smart city investments?

Top benefits realized now and expected by 2021

Now	Three years
1. Ensure safety and security	**1. Generate additional revenue**
2. Improve infrastructure	2. Improve infrastructure
3. Generate additional revenue	3. Ensure safety and security
4. Ability to adapt and innovate	4. Ability to adapt and innovate
5. Attract residents and tourists	5. Citizen satisfaction with services

Fastest growing expected benefits

Reduce budget deficits	**250%**
Reduce capital costs	**62%**
Improve competitiveness	**54%**
Promote economic development	**50%**
Improve sustainability/resiliency	**34%**

Top 10 smart city benefits

Smart city initiatives can generate a host of benefits— but views vary by stakeholder. For example, businesses first and foremost see smart programs raising productivity of city workers and their own employees, while attracting residents and tourists and providing better public services are the main benefits experienced by consumers.

Our research revealed five benefits that all stakeholders agree on: (1) safety and security, (2) economic competitiveness, (3) better public services, (4) increased productivity of businesses and residents, and (5) additional revenue.

Q: What benefits is your city now gaining from its smart city investments?

Top 10 benefits of stakeholders in proxy cities, ranked in declining order

Government	Citizens	Businesses
Productivity of businesses and residents	Attract residents and tourists	Productivity of city workers
Safety and security	Better public services	Productivity of businesses and residents
Attract residents and tourists	Attract business and private investment	Ability to adapt and innovate
Improve inclusiveness	Safety and security	Additional revenue
Economic competitiveness	Economic competitiveness	Economic competitiveness
Better public services	Ability to adapt and innovate	Greater satisfaction with government services
Improved infrastructure	Productivity of city workers	Better public services
Productivity of city workers	Productivity of businesses and residents	Safety and security
Additional revenue	Additional revenue	Improved inclusiveness
Attract business and private investment	Easier commute and access to services	Easier commute and access to services

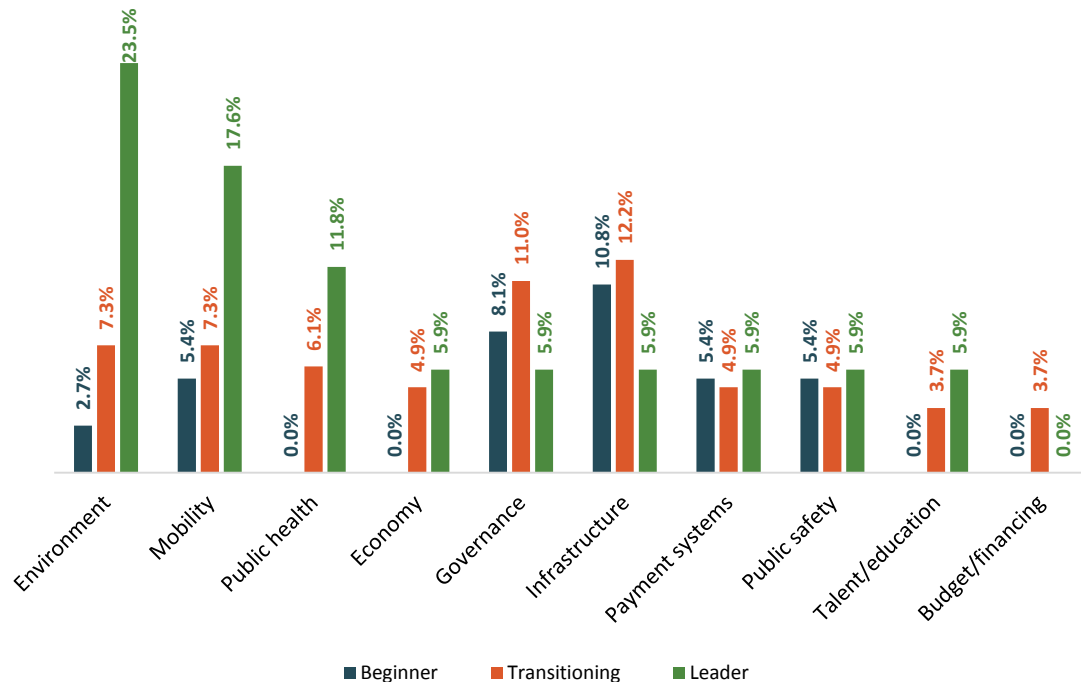# For leaders, environment, mobility, and health generate highest ROI

Leaders realize greater returns on investments across most smart city pillars. For example, about 24% have an ROI of over 7% on investments in environment, 18% have an ROI over 7% on mobility, and 12% have an ROI over 7% on public health.

Beginners and transitioning cities are more likely than leaders to see returns of over 7% on their investments in infrastructure and governance.

None of the beginners surveyed generate an ROI over 7% on public health, economy, talent, and funding--which reflects their lower commitment to these pillars.

Q: What level of return has your city realized on its smart city investments? (% citing large positive >7%)

The ROI on investments in smart city pillars by maturity stage

	Beginner	Transitioning	Leader
Environment	2.7%	7.3%	23.5%
Mobility	5.4%	7.3%	17.6%
Public health	0.0%	6.1%	11.8%
Economy	0.0%	4.9%	5.9%
Governance	8.1%	11.0%	5.9%
Infrastructure	10.8%	12.2%	5.9%
Payment systems	5.4%	4.9%	5.9%
Public safety	5.4%	4.9%	5.9%
Talent/education	0.0%	3.7%	5.9%
Budget/financing	0.0%	3.7%	0.0%

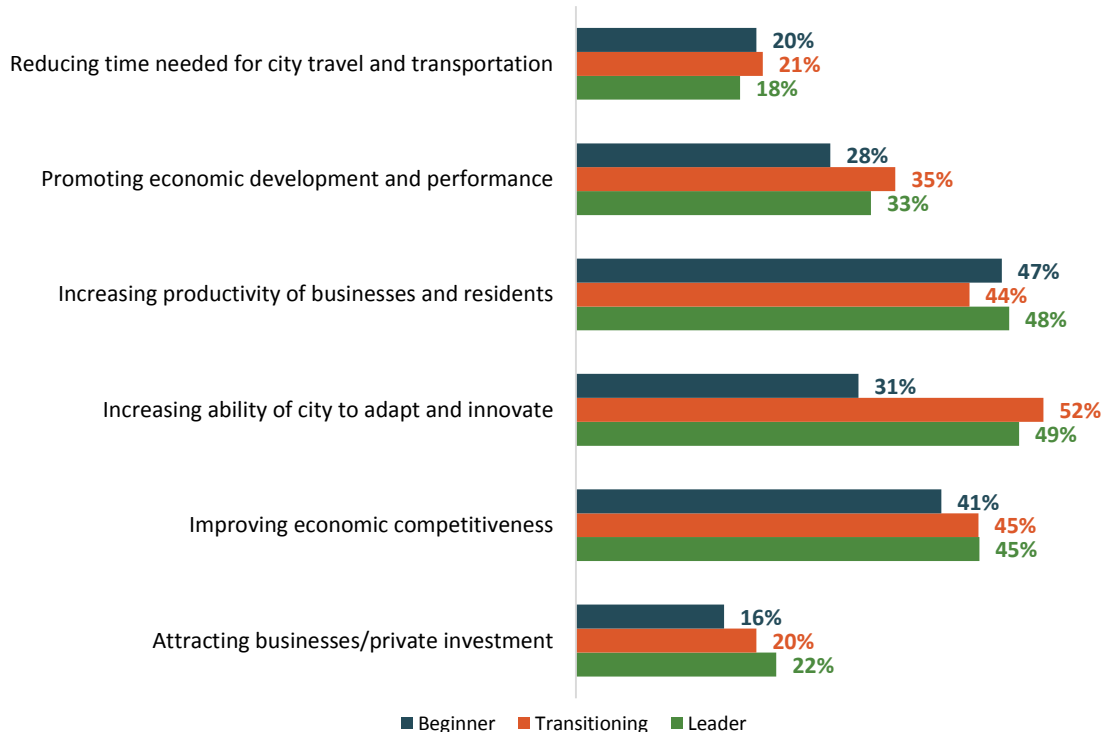■ Beginner   ■ Transitioning   ■ Leader

Businesses are seeing economic benefits from smart city investments

Businesses across cities see common economic benefits from smart city investments. Regardless of stage of smart city maturity, the largest benefits come from increases in productivity, innovation, competitiveness, and economic performance.

These findings demonstrate that city investments in smart technologies can pay off not only in terms of improved services, but also in terms of economic growth.

These advances provide the potential for increased revenues to fund future smart investments.

The economic benefits of investments in smart city pillars by maturity stage

Benefit	Beginner	Transitioning	Leader
Reducing time needed for city travel and transportation	20%	21%	18%
Promoting economic development and performance	28%	35%	33%
Increasing productivity of businesses and residents	47%	44%	48%
Increasing ability of city to adapt and innovate	31%	52%	49%
Improving economic competitiveness	41%	45%	45%
Attracting businesses/private investment	16%	20%	22%

■ Beginner ■ Transitioning ■ Leader

Smart cities drive growth

Since cities were first created in Mesopotamia 7,000 years ago, they have been hotbeds of commerce and innovation. Yet in the early 1980s, some expected technology to make cities obsolete. Instead, it has galvanized their growth.

With cities now generating 80% of global GDP and home to 54% of the world population, their impact has never been more profound. McKinsey expects global urban consumption to grow by $23 trillion between 2015 and 2030.

The spreading use of technology in metro areas—from smart phones and artificial intelligence to driverless cars and wearables—are transforming the urban landscape and how people shop, work, travel, and live.

As cities advance along the smart city maturity curve, they unlock their potential for advancement and growth—and fuel prosperity for citizens and growth for businesses. As Paul Romer's research has shown, over the past 60 years, as countries become more urbanized, GDP per capita has risen.

The results have clear implications. If you want to promote economic growth, you need to make cities work for more of your residents. And smart technologies can increase the density and productivity of cities while addressing the most important urban challenges.

Correlation between GDP per capita and urban share of population
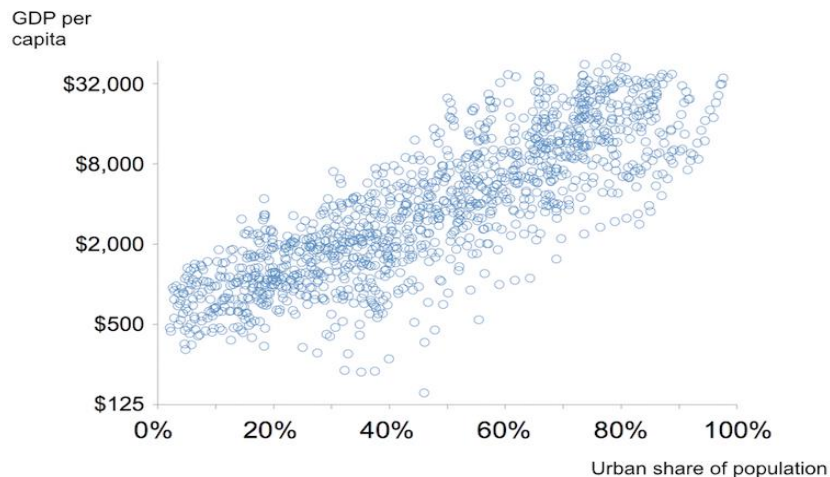
Source: Paul Romer, 2015
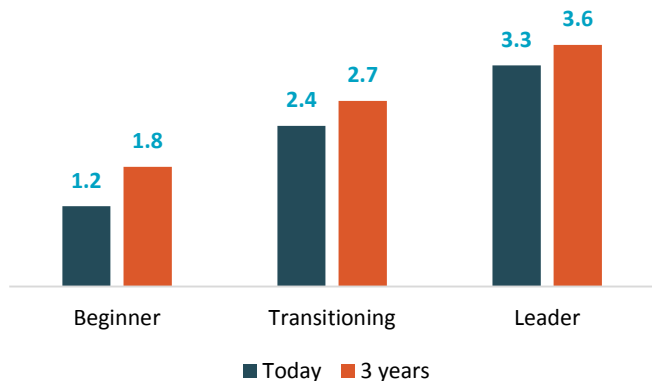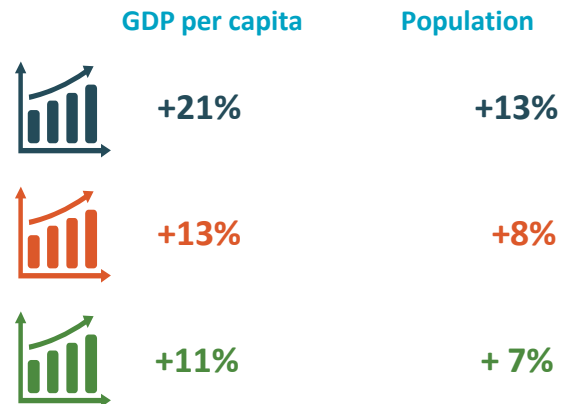
Catalytic impacts

According to our survey, cities across the smart city maturity curve are expected to increase their smart city maturity over the next three years. The biggest increase will be from beginner cities, which will go from an average maturity score of 1.2 to 1.8. As illustrated in our research, smart cities benefits make them more attractive places for people to live and work and for businesses to locate, which will lead to a virtuous cycle of additional economic growth. Our economic analysis found that on average the catalytic impacts associated with becoming a smarter city have the potential to increase GDP per capita by 21% and population growth by 13% over the next three to five years in beginning cities, if they are able to achieve their stated smart city plans. Transitioning and leader cities can potentially see additional GDP per capita and population increases as well, if at a lower rate.

Where will cities be in 3 years?

Beginner: Today 1.2, 3 years 1.8
Transitioning: Today 2.4, 3 years 2.7
Leader: Today 3.3, 3 years 3.6

■ Today ■ 3 years

Beginner cities will see the largest growth in GDP and population

	GDP per capita	Population
	+21%	+13%
	+13%	+8%
	+11%	+ 7%

Beginner ● Transitioning ● Leader ●

Calls to Action

10 actionable insights from our research

1. **Start with a vision and roadmap to your smart city future.** Without the right vision, plans, and resources in place, smart city programs will not reach their full potential—a piecemeal approach is all too common, and will prove ineffective in the long run. To develop this vision and roadmap, city governments should first assess and consider the concerns of citizen and business stakeholders to ensure alignment with their priorities and to get their buy in. According to Mark Saunders of Ferrovial, "City leaders need to match top-down initiatives with bottom-up sentiment to create sustainable value."

2. **Make sure you have a strong foundation.** Many beginner cities jump into digitally transforming areas such as mobility, public safety, and environment, before they lay down the foundational pillars, such as governance, economy, infrastructure, talent, and funding, which are vital to long-term smart city success. Talent, for example, is the lifeblood of smart cities, yet many cities are not doing enough to nurture the talent and skills needed for the digital age. Smart funding is often overlooked, although no smart city plan can be implemented without it. According to Amanda Clack, Head of Strategic Advisory at CBRE, "Future cities will only succeed by putting people at their heart; to interact with each other and their surroundings in a way that creates a true sense of place that combines governance, innovation, and culture."

3. **Put in place the needed infrastructure.** "In the age of the smart city, 'architecture' doesn't just mean physical buildings anymore—it means the 'technology architecture' that will optimize the myriad different 'smart' initiatives cities will have to make to be attractive to new waves of citizens," according to Ben Pring of Cognizant. "Cities of the future will have 'operating systems' that tie the physical and digital together." To accomplish this, cities will need fast and reliable fixed and mobile broadband, public WiFi, citywide data platforms, shared IT architecture, and scalable systems as well as the processes and standards to support smart initiatives. And remember, as cities go digital, the risk of cyberattacks and potential vulnerabilities multiply. Avoid making cybersecurity an afterthought by incorporating it in every step of your digital transformation plan.

10 actionable insights from our research

4. Keep pace with advanced technologies. "In this age of rapidly changing technology," says Joseph Viscuso, SVP of Pennoni, "constituents of cities around the world expect their leaders to provide platforms that will allow them access to these digital innovations." With Silicon Valley setting the digital pace, cities will need to embrace core technologies like cloud, biometrics, and mobile apps, as well as emerging ones, such as AI, IoT/sensors, smart beacons, geospatial technology, and chatbots. While blockchain, drones, augmented and virtual reality (AR/VR), AI, and V2X are now used by fewer than 1 out of 10 cities, these technologies will be skyrocketing in use over the next three years. Adopting these technologies is not only key to smart city initiatives, but to meeting the needs of constituents, and attracting the talent to advance your digital agenda.

5. Capitalize on data and analytics. Data is the rocket fuel for smart city transformation. With IoT, social media, and direct engagement with citizens, cities have access to tremendous amounts of data. Harnessing it to create services that drive real value to the community is both an opportunity and a challenge. To meet that challenge, cities need to ensure they are gathering, analyzing, and integrating a wide array of data, including newer types such as data generated by IoT and AI. Making the data accessible to stakeholders is not only best practice, but it could provide a new revenue stream. But to succeed, cities clearly need to put in the proper safeguards to ensure citizen privacy and appropriate use. "To meet the growing demands of increasingly mobile city dwellers during their work and leisure, cities must smarten up their acts by devising data insights and automation to make these user journeys seamless and personalized," offers Mike Gedye of CBRE.

6. Develop digital ecosystems to facilitate your city's transformation. Smart city leaders realize they cannot do everything on their own, nor is it expedient or cost-effective. "The best and most sustainable way to implement social impact policy is for the public sector to partner with the private sector—which has a business interest in its success," says Miguel Gamiño Jr. of Mastercard. Indeed, the most successful cities find the right mix of internal teams and an external ecosystem of suppliers and partners, including technology vendors, consultants, and outsourcing providers. Building academic partnerships can help accelerate your innovation plans and give your city greater access to talent. Explore creative ecosystem approaches, such as revenue sharing, concession financing, and as-a-service models.

10 actionable insights from our research

7. **Make sure to budget enough**. A few scattershot investments are not enough to make important progress in becoming a smart city—it's vital to allocate sufficient funding from both the operating and capital budget. On average, we found that cities are allocating about 15% of their operating budgets and 17% of their capital budgets to smart city programs. However, leaders are spending more—about 20% of their capital budgets. To supplement public budgets and bond issues, consider using new funding tools, including social impact bonds and pay-for-success agreements. And some digital transformation projects will help with funding. "Finding money for innovation products is difficult, particularly in an era of shrinking budgets," says Susan O'Connor of Oracle. "Modernizing front- and back-office operations with the cloud can produce savings that could fund those critical programs."

8. **Invest in your city's multi-modal future.** With populations growing and congestion increasing, cities will need to diversify modes of transportation to include ride-sharing, car-sharing, bike-sharing, and other innovative approaches. But at the same time, smart cities must continue to maintain the efficiency and reliability of their public transportation to ensure it stays competitive with private-sector mobility options. Smart use of data, apps, road sensors, and other digital solutions can boost the performance of traditional transportation modes and raise ridership and revenue. "Mobility is a significant opportunity for city governments," says Mark Saunders of Ferrovial, "because it benefits multiple factors, including time savings and emissions improvements, as well as giving a boost to the local economy."

9. **Move to digital payments.** Smart cities are moving to a less-cash future: digital payments systems are essential for online and mobile access to city services, efficient mobility, and secure government transactions, and offer greater efficiency and improved record keeping, as well as reductions in theft, public-sector corruption, and shadow economy activity. In addition to using digital payments themselves, cities should offer incentives to the private sector to make the switch.

10. **Follow the leaders.** Cities should take inspiration from how leaders approach their smart city investments—starting with a roadmap and first getting the foundations in order, including a sound governance structure, sufficient financing, and incentives to attract talent. After getting their foundations in place, transitioning and leader cities can realize more significant returns through investments in environment, mobility, and public health. They can then tap into the virtuous cycle of economic growth to bring their city to new heights. "Cities should build on each other's progress and learn from each other's efforts," advises Miguel Gamiño Jr of Mastercard. "In facing similar challenges, cities have the opportunity to establish common goals and standards. Digital solutions make it possible for cities to make the journey to progress together."

Smarter Cities 2025

Building a sustainable business and financing plan

Visit the Smarter Cities 2025 microsite to access the full suite of products produced for this research initiative.

About ESI ThoughtLab

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 economic consultancy with links to the academic community.

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