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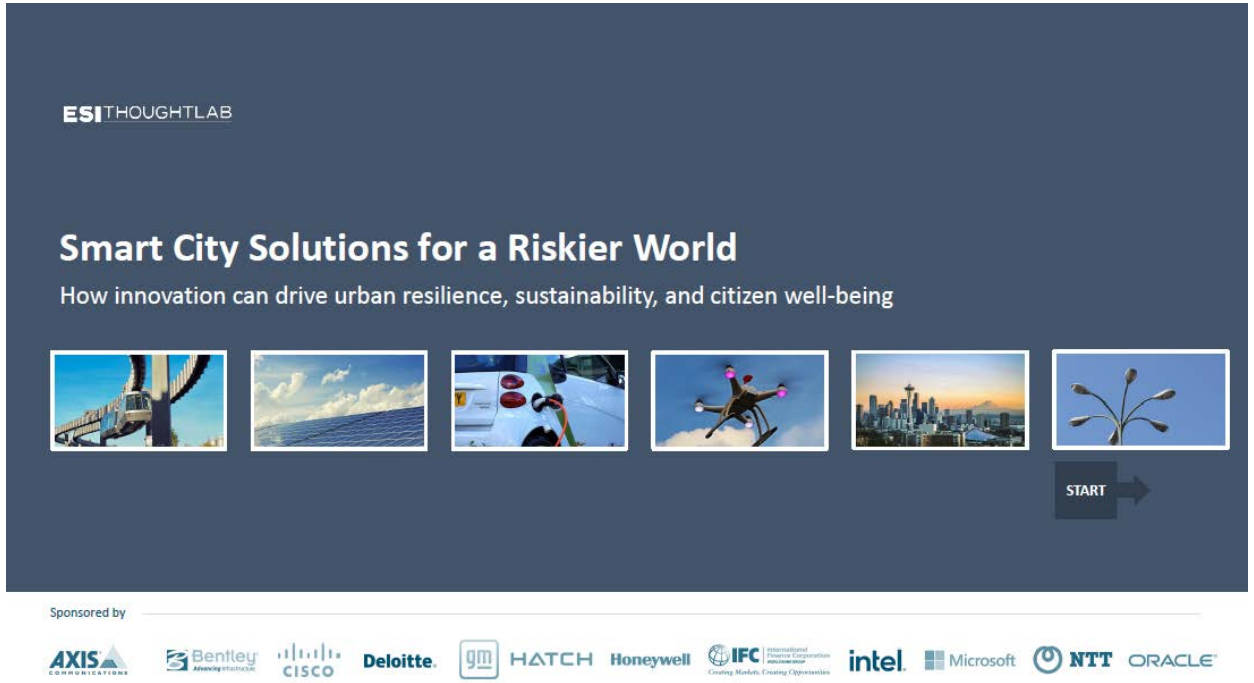
Smart City Solutions for a Riskier World

How innovation can drive urban resilience, sustainability, and citizen well-being



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ESI THOUGHTLAB

Smart City Solutions for a Riskier World

How innovation can drive urban resilience, sustainability, and citizen well-being






START

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Introduction

In the pandemic era, ensuring a healthy, safe, and prosperous future for citizens has been a burning imperative for city leaders. But with city budgets under pressure, it also has been their biggest challenge. COVID-19 has served as a stress test for cities as businesses and services were shut down and medical facilities stretched to their limit. It also exposed weaknesses in digital infrastructure and resilience as disruptions emerged unexpectedly with far-reaching aftershocks. Simultaneously, cities are facing mounting pressures to address vulnerabilities related to cybersecurity and climate change.

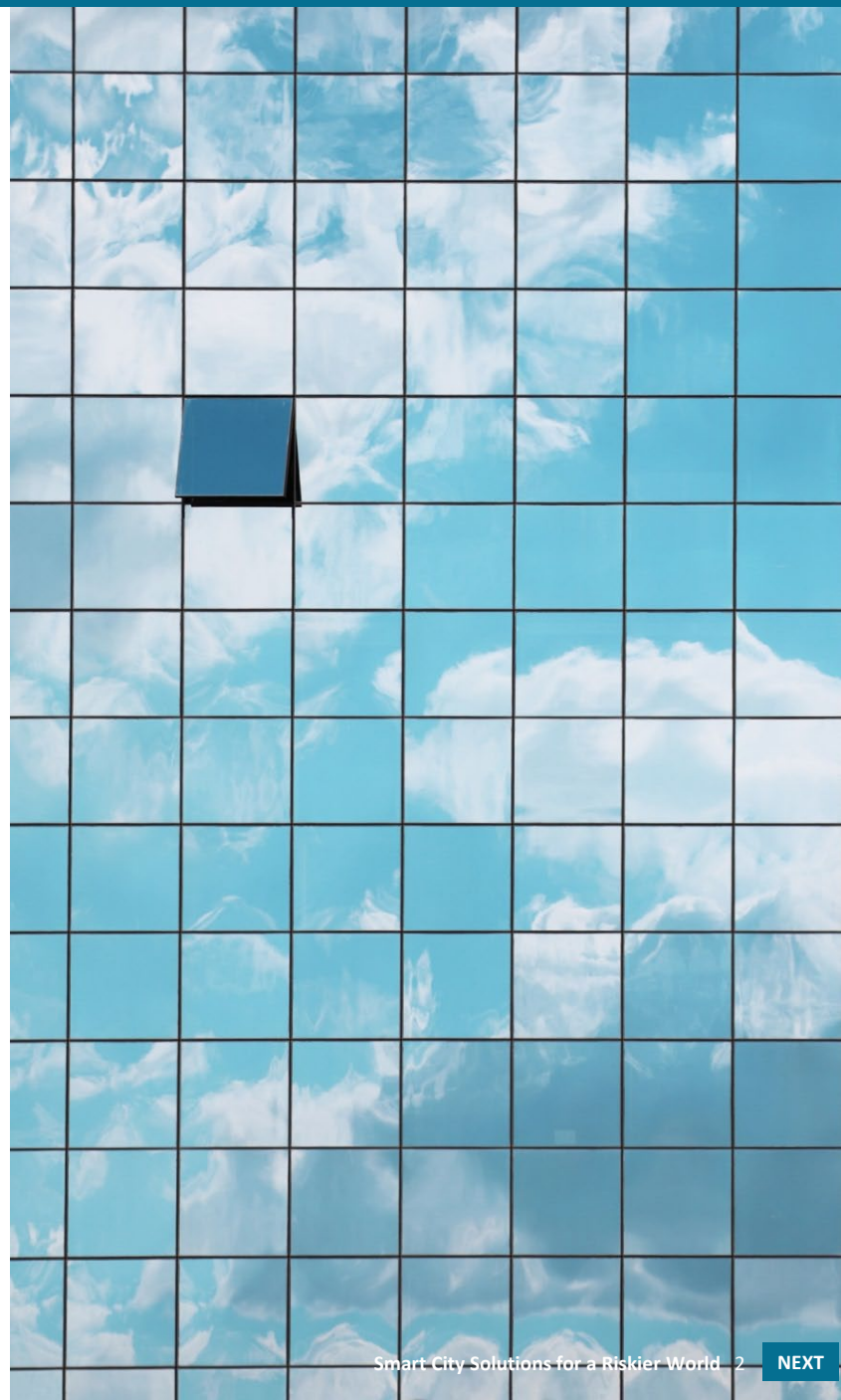
Yet the pandemic also has been a catalyst for change. It is accelerating the reliance on technology, smart innovation, and e-commerce, while transforming citizen behaviors and expectations, and redefining how people work and live. It is also underscoring the role of collaboration among business, government, and academia to achieve social, environmental, and economic goals.

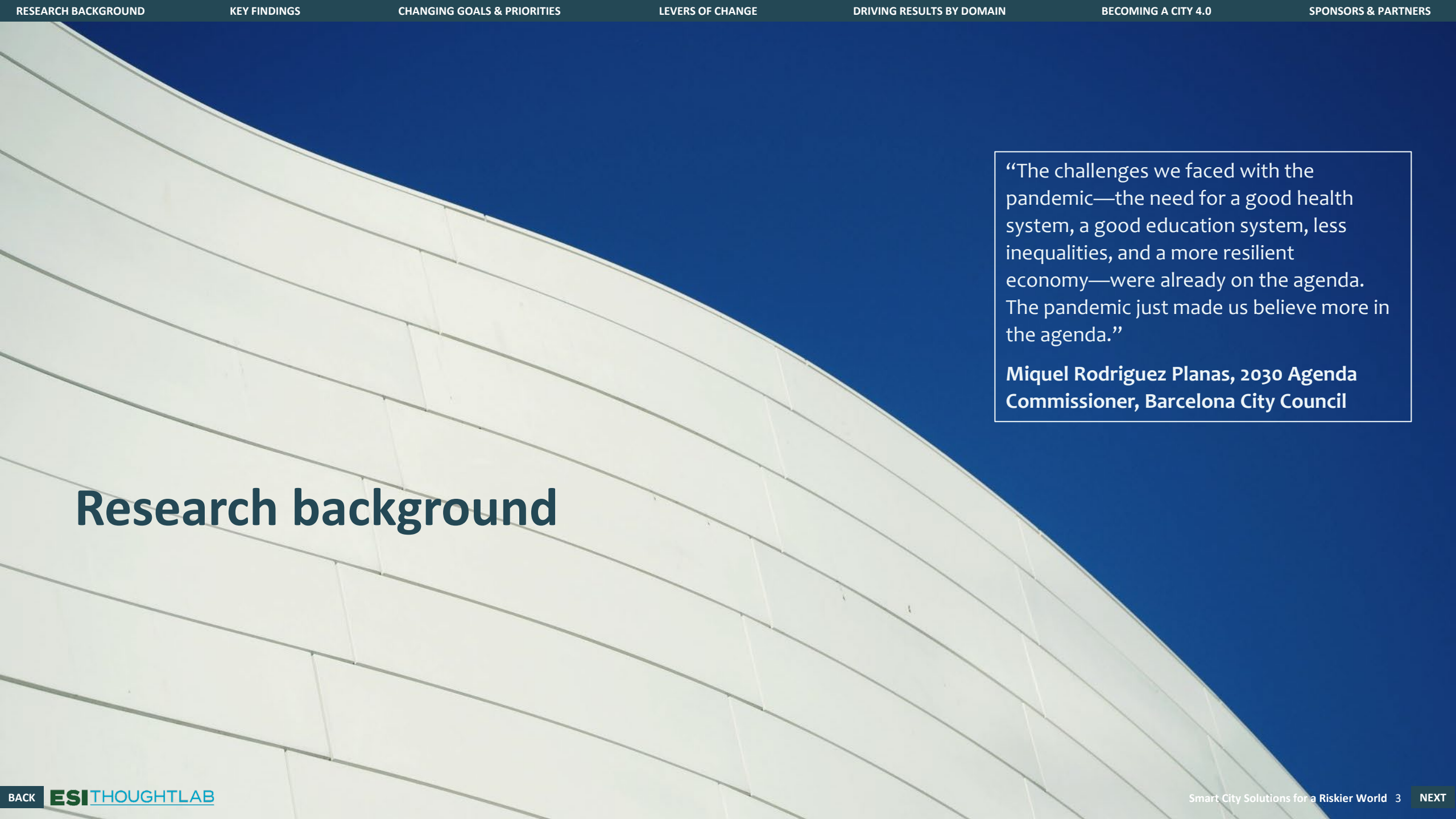
To succeed in the post-COVID world, urban leaders need access to evidence-based analysis showing the innovative technologies, solutions, and business models that will work best, particularly when the next disruption hits.

ESI ThoughtLab has collaborated with a global coalition of business, government, and academic leaders to provide city decision-makers with such an evidence-based roadmap. Called **Smart City Solutions for a Riskier World,** this research initiative explores how 167 cities—with diverse populations and economies—use smart innovation and public-private partnerships to drive results.

Our goal is to provide an evidence-based roadmap to urban resilience and sustainability and to open a valuable dialogue on the future of cities among government, business, and academic leaders.

Lou Celi, CEO
ESI ThoughtLab





> "The challenges we faced with the pandemic—the need for a good health system, a good education system, less inequalities, and a more resilient economy—were already on the agenda. The pandemic just made us believe more in the agenda."
>
> **Miquel Rodriguez Planas, 2030 Agenda Commissioner, Barcelona City Council**

Research background

Our research methodology

To explore how cities are achieving their social, environmental, and economic goals—and the solutions that work best—ESI ThoughtLab conducted a five-pronged research program:

1. **Surveyed and benchmarked 167 cities.** We analyzed their use of smart technologies and data analytics across all parts of their urban ecosystem, as well as in-depth data on their city investments, outcomes, and returns.
2. **Created a *City Sustainability Progress Index*.** We used the survey data to develop a scoring methodology allowing us to categorize cities by their progress against the UN's 17 Sustainable Development Goals (SDGs).
3. **Gathered city data from trusted sources.** We collected data on city services and quality of life from the World Bank, Numbeo, IESE, and other respected sources. This data was integrated and correlated with our survey data.
4. **Conducted interviews with urban leaders and experts.** To identify best practices and provide case studies, we had in-depth discussions with government decision-makers and business leaders in smart cities around the world.
5. **Established a multi-disciplinary advisory board.** Our advisory board of city leaders, corporate executives, and academic experts provided valuable guidance and insights to ensure the acuity of our analysis.

The five interconnected stages of our research

The UN's Sustainable Development Goals

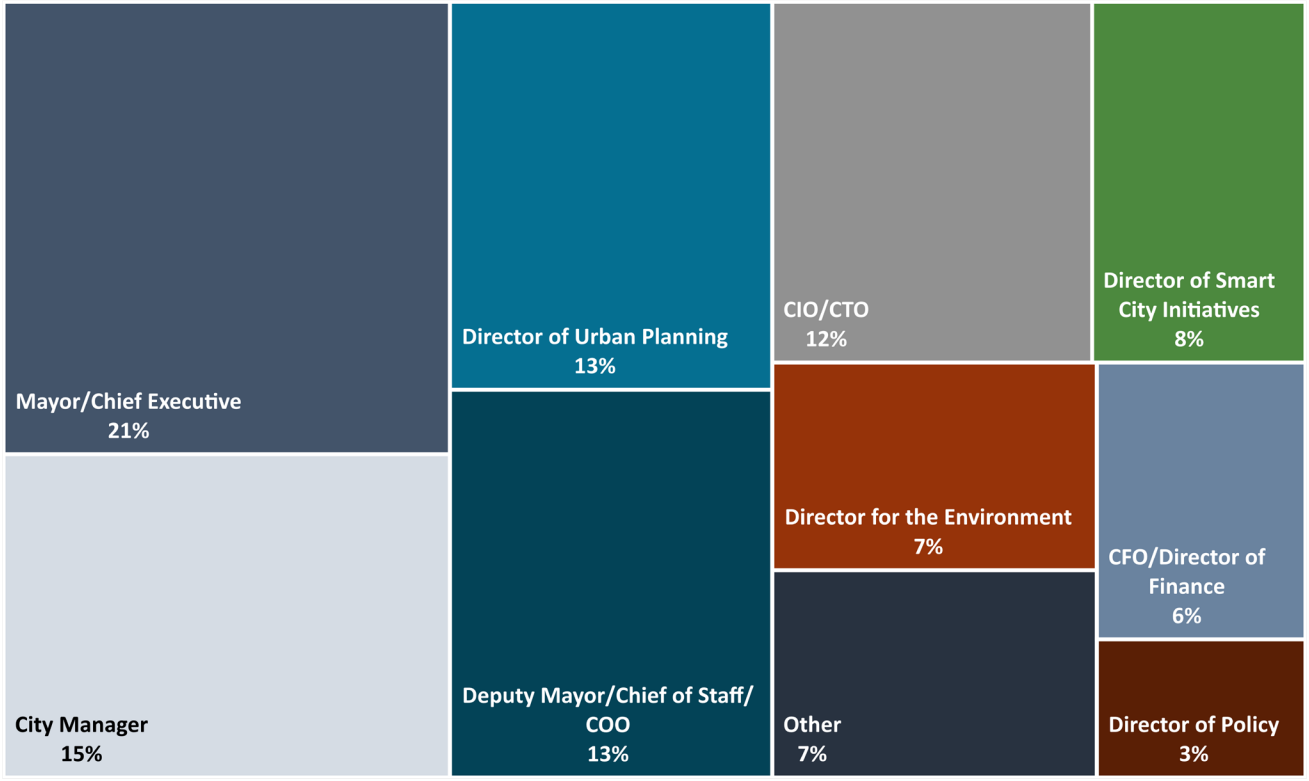
We surveyed decision-makers in 167 cities

167 Cities

82 Countries

526.8 million residents

6.8% of global population



We administered the survey through personal phone interviews with city officials from 167 pre-screened cities in 82 countries. The cities are home to over 526 million residents, representing 6.8% of the world population.

Twenty-one percent of the respondents were mayors or chief executives; an additional 15% were city managers. Approximately 30% held policy or operational roles, including chief of staff, or director of planning or policy. About 20% had senior positions overseeing technology or smart city initiatives.

Respondents from emerging markets tended to be mayors or deputy mayors, while those from developed economies were more likely to be city managers or directors of technology or policy.

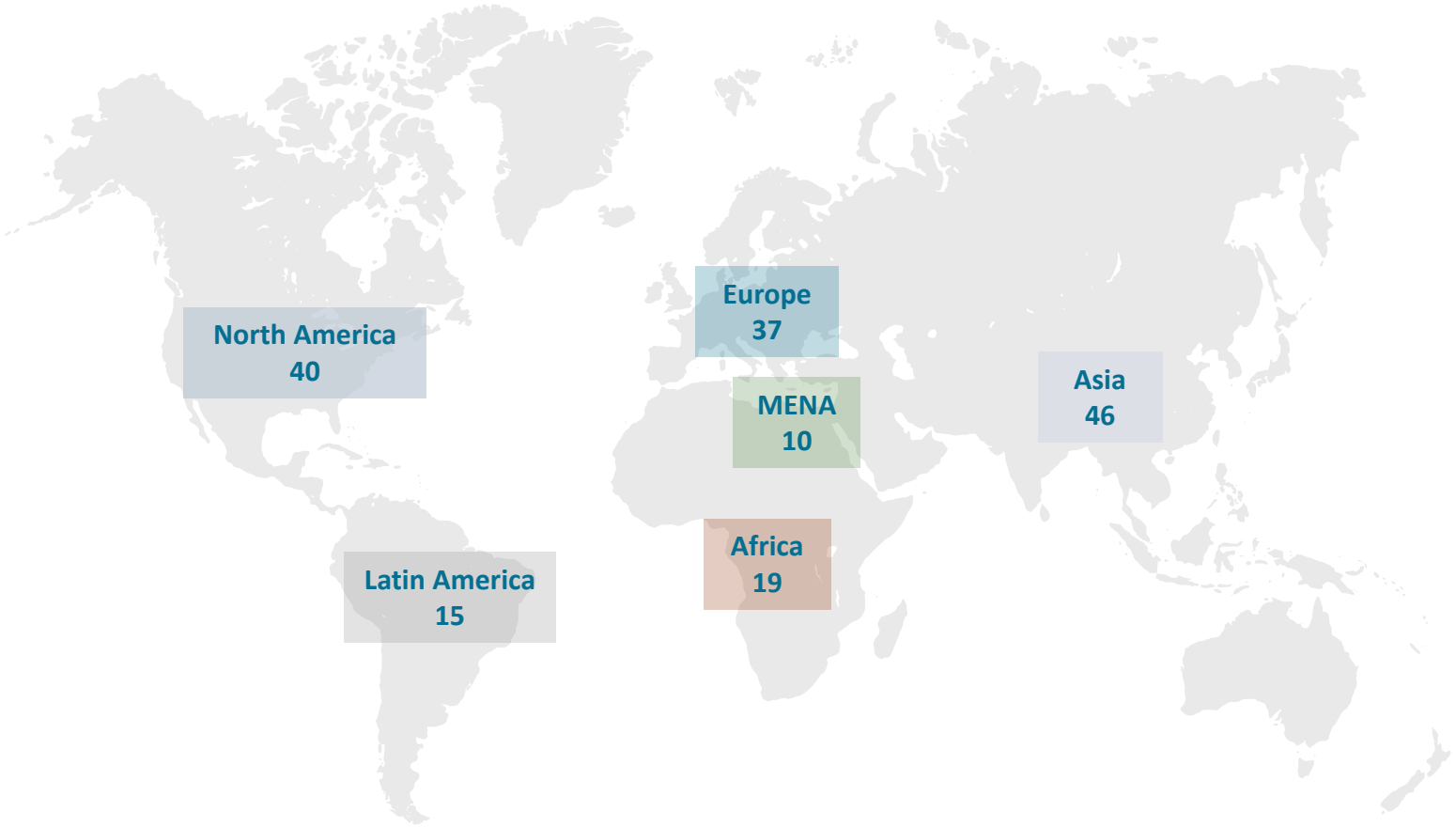
The survey responses helped us understand how cities are achieving their social, environmental, and economic goals and how these may change due to the pandemic. We used the UN's Sustainable Development Goals (SDGs) as a framework.

We followed strict quality control measures to ensure the accuracy of the reported data, including vetting it with analysis from respected third-party sources, checking questionable data with cities, and reviewing the output with the advisory board.

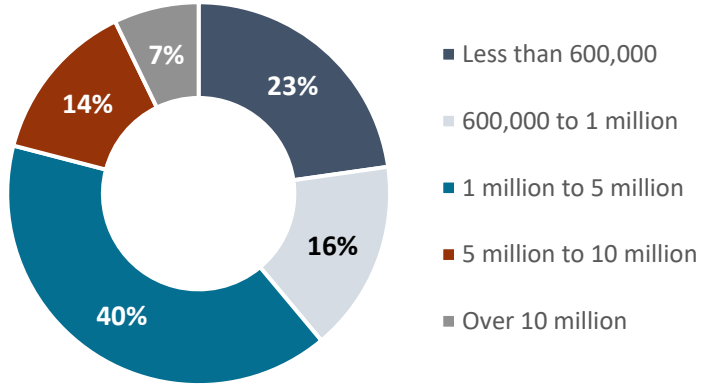
Our sample covered cities of varying sizes across six regions

The 167 cities range in population from 80,000 to nearly 27 million. Thirty-nine percent of the cities have less than one million inhabitants. The cities vary by level of economic development. Fifty-three percent are in emerging markets and 47% in developed countries.

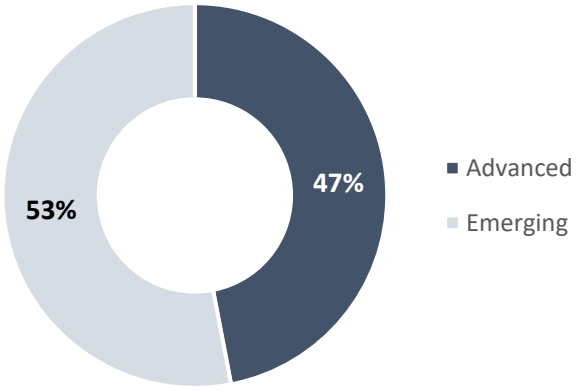
Number of cities by region



By population



By level of development

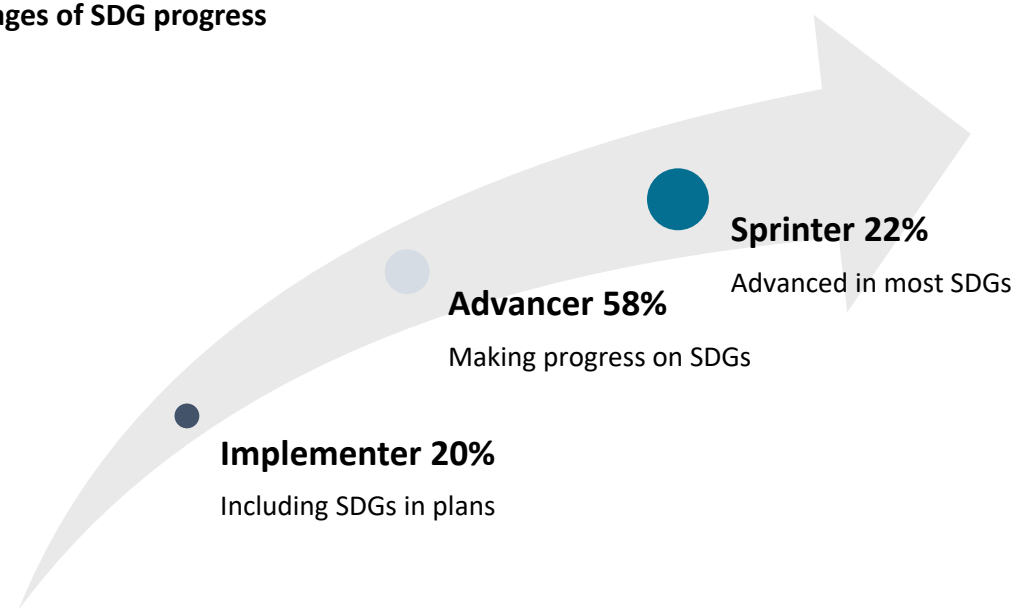


We categorized cities into three stages of SDG progress

A prime objective of this research was to assess how smart urban solutions—such as use of emerging technologies and forging of new partnerships—can help cities achieve the SDGs. To measure the headway that cities have made in driving the SDGs, we developed an SDG progress framework.

Our framework categorizes cities into three groups: implementers, which are in an early stage of SDG adoption; advancers, which are making progress on a range of SDGs; and sprinters, which are making fast progress on most areas of sustainable development. Twenty percent of cities are classified as implementers, 58% as advancers, and 22% as sprinters.

Three stages of SDG progress



Our SDG progress framework

We grouped the cities into three stages of sustainable development progress: implementers, advancers, and sprinters. We classified them based on their scores across the following criteria:

1. The number of SDGs a city has included in its plans

2. The progress a city has made on each of the SDGs

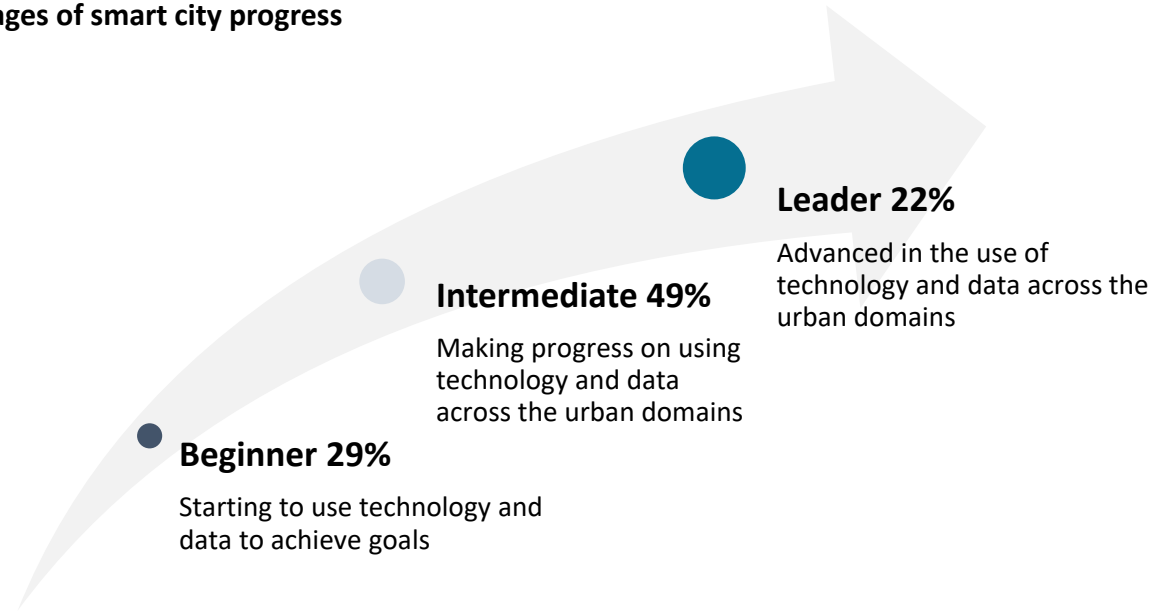
3. The steps a city is taking to achieve the SDGs:

- Regularly monitors SDG efforts
- Assesses areas where the city lags
- Designates a department to implement SDGs
- Gathers high-level support for its SDG program
- Conducts a voluntary local review (VLR)
- Enjoys a reputation as a leader in SDG adoption

We also classified cities by their progress in applying smart solutions

Our economists created a smart city maturity framework to assess which cities are ahead in using digital solutions and technologies to achieve their social, environmental, and economic goals. We classified cities based on their progress on harnessing technology and data across the urban domains, as well as their ability to foster citizen and stakeholder engagement. Twenty-nine percent of cities are classified as beginners, 49% as intermediates, and 22% as smart city leaders.

Three stages of smart city progress



Our smart city maturity framework

We categorized each city into one of three stages of smart city maturity: beginners, intermediates, and leaders. We classified cities based on scores across the following criteria:

1. Level of digitization across the urban domains

2. Competence in using data and analytics

3. Progress on fostering citizen engagement

We applied an additional filter for leaders. To be classified as a leader, a city had to self-identify as either advanced or very advanced in its implementation of smart city initiatives.

Key findings

"The SDGs are holistic on a global level. When you take them down to the local level, with how you measure things, how you create local ecosystems, or how you create partnerships, if you can keep the three dimensions—social, environmental, and economic—and the principles of the SDGs, then you can create useful policies, useful projects, and more useful discussions."

Øyvind Tanum, Head of Smart City, Trondheim

When smart and sustainable meet: Cities 4.0

To analyze the impact of smart city solutions on sustainability, we identified a subset of SDG sprinters that also lead in using advanced technology and data analytics.

The pandemic has been a catalyst for remarkable technological, business, and social change, which will continue after the health crisis ends. With the expectations of citizens rising, and businesses gearing up for the Fourth Industrial Revolution, the most successful cities will be those that are advanced in using smart technology and data and deploy them to drive the SDGs. Such cities will be far along in their digital transformation, fully sustainable, and skilled in the new ways of doing business.

We call these cities, Cities 4.0.

"The importance of cities to advance SDG policies cannot be understated. Smarter cities will lay the groundwork for collaborative governance in dealing with the world's most wicked problems. This research goes to the heart of the resiliency of 21st-century cities, which we labeled Cities 4.0."

Frank V. Zerunyan, Professor of the Practice of Governance, University of Southern California

What sets Cities 4.0 apart?

They are further ahead in smart city initiatives

On average, they widely deploy 14 smart city projects vs. an average of seven for others

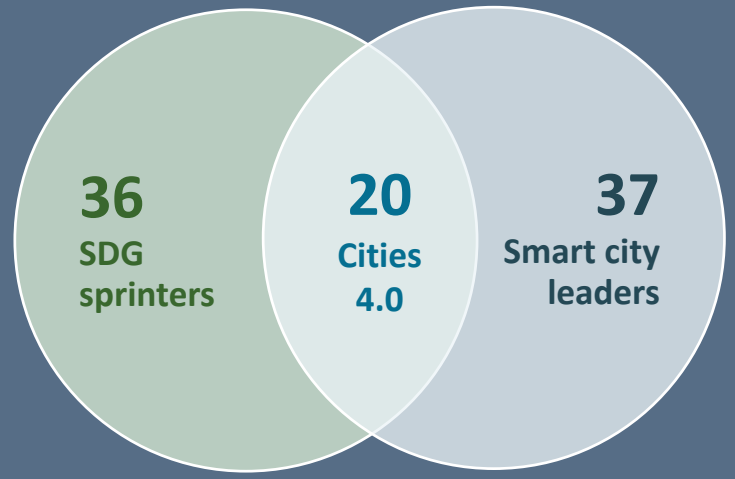
They have superior infrastructure

Better public transportation, roads, parks, healthcare, and digital connectivity

They have made the greatest progress on nearly all SDGs

On average, 86% have made progress across all SDGs vs. 62% of all cities

Smart meets sustainable: 20 cities



Cities 4.0

- Aarhus
- Athens
- Baltimore
- Barcelona
- Berlin
- Birmingham
- Boston
- Copenhagen
- Helsinki
- London
- Los Angeles
- Madrid
- Moscow
- New York
- Orlando
- Paris
- Philadelphia
- Singapore
- Tallinn
- Vienna

Our cities categorized by SDG progress

Sprinter (22%)

Aarhus
Accra
Amman
Athens
Baltimore
Barcelona
Berlin
Birmingham
Bogota
Boston
Bratislava
Buenos Aires
Copenhagen
Helsinki
Kyiv
London
Los Angeles
Madrid
Mexico City
Montevideo
Moscow
Mumbai
New York
Orlando
Osaka
Paris
Philadelphia
Pittsburgh
Quebec
Sao Paulo
Singapore
Stockholm
Suzhou
Tallinn
Tokyo
Vienna

Advancer (58%)

Abu Dhabi
Addis Ababa
Adelaide
Ahmedabad
Almaty
Amsterdam
Asuncion
Atlanta
Auckland
Austin
Bangkok
Beijing
Belgrade
Brantford
Bucharest
Busan-Ulsan
Calgary
Canberra
Chengdu
Chennai
Chicago
Cincinnati
Colima
Columbus
Dehradun
Denver
Detroit
Doha
Dublin
Edmonton
Ekurhuleni
El Paso
Fukuoka
Galway
Hangzhou
Hanoi
Honolulu
Istanbul
Jakarta
Jerusalem
Kansas City
Kigali
Kuala Lumpur
Kuwait City
Liege
Lima
Lisbon
Ljubljana
Lucknow
Ludhiana
Manama
Manchester
Manila
Mariupol
Monterrey
Montreal
Munich
Nanjing
Nashville
Newark
Ningbo
Oakland
Oslo
Panama City
Phnom Penh
Phoenix
Portland
Porto
Prague
Quezon City
Quito
Rabat
Raleigh, NC
Reykjavik
Rio de Janeiro
Riyadh
Rotterdam
San Antonio
San Diego
San Francisco
San Jose
Santiago de Chile
Seattle
Seoul
Shanghai
St Petersburg
Tbilisi
Toronto
Touba
Tulsa
Tunis
Vancouver
Victoria
Warsaw
Washington, DC
Wuhan
Xiamen

Implementer (20%)

Allentown
Bamako
Benin City
Blantyre
Cairo
Changchun
Chongqing
Cotonou
Dalian
Dar es Salaam
Guiyang
Harare
Hefei
Ibadan
Jaipur
Jena
Jiaozuo
Jinan
Kampala
Kano
Kinshasa
Kochi
Lagos
Lahore
Libreville
Lusaka
Monrovia
Pearland
Pune
Qingdao
San Juan
Tianjin
Toyama
Yangon

Cities in bold are also classified as Cities 4.0.

Our cities categorized by smart city progress

Leader (22%)

Aarhus
Abu Dhabi
Amsterdam
Athens
Atlanta
Auckland
Baltimore
Barcelona
Berlin
Birmingham
Boston
Chicago
Columbus
Copenhagen
Detroit
Dublin
Helsinki
Istanbul
London
Los Angeles
Madrid
Montreal
Moscow
New York
Orlando
Paris
Philadelphia
Prague
Rotterdam
Seattle
Seoul
Singapore
Tallinn
Toronto
Vancouver
Vienna
Washington

Intermediate (49%)

Accra
Addis Ababa
Adelaide
Amman
Asuncion
Austin
Beijing
Belgrade
Bogota
Bratislava
Bucharest
Buenos Aires
Busan-Ulsan
Cairo
Calgary
Canberra
Chengdu
Chennai
Cincinnati
Denver
Doha
Edmonton
Ekurhuleni
El Paso
Fukuoka
Guiyang
Hanoi
Harare
Hefei
Honolulu
Jakarta
Jerusalem
Jiaozuo
Kano
Kansas City
Kinshasa
Kuala Lumpur
Kuwait City
Kyiv
Lisbon
Ljubljana
Lucknow
Ludhiana
Manama
Manila
Monterrey
Montevideo
Mumbai
Munich
Nanjing
Nashville
Newark
Oakland
Osaka
Oslo
Panama City
Phoenix
Pittsburgh
Portland
Porto
Pune
Quebec
Quito
Rabat
Raleigh
Reykjavik
Rio de Janeiro
Riyadh
San Antonio
San Diego
San Francisco
Santiago de Chile
Sao Paulo
Shanghai
St Petersburg
Stockholm
Suzhou
Tokyo
Tulsa
Victoria
Warsaw

Beginner (29%)

Ahmedabad
Allentown
Almaty
Bamako
Bangkok
Benin City
Blantyre
Brantford
Changchun
Chongqing
Colima
Cotonou
Dalian
Dar es Salaam
Dehradun
Galway
Hangzhou
Ibadan
Jaipur
Jena
Jinan
Kampala
Kigali
Kochi
Lagos
Lahore
Libreville
Liege
Lima
Lusaka
Manchester
Mariupol
Mexico City
Monrovia
Ningbo
Pearland
Phnom Penh
Qingdao
Quezon City
San Jose
San Juan
Tbilisi
Tianjin
Touba
Toyama
Tunis
Wuhan
Xiamen
Yangon

Cities in bold are also classified as Cities 4.0.

Cities are focusing on the SDGs around people and prosperity

The UN categorizes the SDGs into five Ps: people, planet, prosperity, peace, and partnerships. Most cities include SDGs under each of these Ps in their urban development plans. Cities are doing the most with SDGs relating to people: 91% include no poverty, 89% include good health and well-being, and 86% include quality education in their plans. Cities are also focusing on prosperity, with 86% including decent work and economic growth in their plans, and 78% incorporating sustainable cities and communities. The SDGs around planet, peace, and partnerships are included slightly less often.

% of cities including SDGs in their plans

77%
average percentage of cities that include each of the SDGs in their plans

PEOPLE
End poverty and hunger in all forms and ensure dignity and equality

No poverty (91%)
Good health and well-being (89%)
Quality education (86%)
Gender equality (77%)
Zero hunger (75%)

PLANET
Protect our planet's natural resources and climate for future generations

Life on land (83%)
Clean water and sanitation (78%)
Life below water (77%)
Responsible consumption and production (69%)
Climate action (64%)

PROSPERITY
Ensure prosperous and fulfilling lives in harmony with nature

Decent work and economic growth (86%)
Industry, innovation, and infrastructure (79%)
Sustainable cities and communities (78%)
Affordable and clean energy (72%)
Reduced inequalities (60%)

PEACE
Foster peaceful, just, and inclusive societies

Peace and justice strong institutions (78%)

PARTNERSHIPS
Revitalize the global partnership for sustainable development

Partnerships for the goals (71%)

Q6a: Which of the SDGs are included in your city's plans and on which of them has your city made considerable progress?

SDG scorecard: Where cities have made the most progress

Cities have made the most headway on areas related to people and prosperity: no poverty, decent work and economic growth, quality education, and good health and well-being.

They have made the least progress on zero hunger, climate action, and reduced inequalities, the same SDGs that are least included in their plans. With more manageable populations, small cities are typically making more progress on the SDGs than large ones: 64% vs. 58%. On average, 74% of cities in advanced economies are making progress on the SDGs, compared with half of those in emerging markets. Not surprisingly, SDG sprinters are making far more headway than implementers or advancers. Cities 4.0 are the top performers, with almost nine out of 10 making considerable progress on 11 of the SDGs.

		Population*			Economic development		SDG leadership			
SDGs	All	Small	Medium	Large	Advanced	Emerging	Implementers	Advancers	Sprinters	Cities 4.0
No poverty	82%	80%	79%	91%	84%	81%	53%	88%	100%	90%
Decent work and economic growth	74%	72%	79%	66%	89%	60%	41%	80%	88%	85%
Quality education	70%	72%	70%	66%	82%	59%	38%	75%	88%	85%
Good health and well-being	70%	77%	69%	60%	90%	52%	29%	77%	81%	95%
Sustainable cities and communities	67%	74%	64%	60%	81%	55%	35%	77%	69%	70%
Industry, innovation, infrastructure	66%	75%	61%	60%	87%	48%	18%	77%	69%	95%
Life on land	65%	77%	60%	51%	87%	44%	18%	74%	75%	90%
Clean water and sanitation	63%	71%	58%	57%	82%	45%	18%	71%	88%	80%
Gender equality	61%	65%	60%	57%	77%	47%	9%	70%	81%	90%
Affordable and clean energy	57%	57%	55%	60%	63%	51%	35%	55%	81%	85%
Responsible consumption, production	56%	55%	54%	63%	61%	52%	32%	57%	69%	85%
Partnerships for the goals	56%	57%	54%	60%	67%	47%	29%	59%	69%	80%
Peace and justice strong institutions	56%	69%	49%	46%	73%	41%	24%	58%	88%	80%
Life below water	55%	49%	61%	54%	57%	53%	41%	52%	69%	85%
Zero hunger	53%	58%	58%	34%	77%	32%	6%	59%	81%	85%
Climate action	50%	37%	55%	66%	35%	64%	56%	42%	69%	65%
Reduced inequalities	47%	46%	51%	40%	63%	32%	18%	48%	63%	75%
Average	**62%**	**64%**	**61%**	**58%**	**74%**	**51%**	**29%**	**66%**	**78%**	**84%**

* Small = 600,000 to 1m inhabitants; medium = 1m to 5m inhabitants; large = 5m to 10m inhabitants.
Q6a: Which of the SDGs are included in your city's plans and on which of them has your city made considerable progress? blue=high, gray=low

European cities lead the way, while African cities trail behind

European cities have made the most progress, with an average of 77% making considerable headway on each of the SDGs.

North American cities are close behind with 71%. Africa has made the least progress, with an average of just 33%, followed by Latin America with 47% and Asia with 58%.

Every city in MENA and 87% of those in Latin America have made considerable progress on poverty. European and North American cities are well ahead on good health, decent work, industry and innovation, and sustainable cities.

With increasing temperatures and sea levels threatening their citizens and economies, African cities are moving most aggressively on climate action.

Of course, many of these differences are related to budgetary capacity, with cities in advanced economies having greater resources to devote to the SDGs.

> "Africa faces the most challenges in meeting the SDG commitments, with its high levels of environmental degradation, poverty, and unemployment. However, social media and high mobile broadband penetration provide some unique opportunities for smart city solutions."
>
> **Gerald Uche Maduabuchi, Director of Sales, Panorama Data Solutions**

Where cities have made considerable progress

Less

Africa

Climate action	58%
Partnerships	47%
Life on land	42%
Good health	42%
Quality education	42%
Decent work	42%
No poverty	42%
Average	**33%**

Latin America

No poverty	87%
Sustainable cities	60%
Gender equality	60%
Responsible consumption	60%
Decent work	53%
Climate action	53%
Average	**47%**

Moderate

Asia

No poverty	91%
Decent work	74%
Quality education	72%
Climate action	67%
Life on land	67%
Good health	61%
Sustainable cities	59%
Average	**58%**

MENA

No poverty	100%
Affordable & clean energy	90%
Partnerships	90%
Industry & innovation	80%
Gender equality	80%
Quality education	70%
Average	**63%**

More

Europe

Good health	95%
Decent work	92%
Clean water	86%
Sustainable cities	86%
Industry, innovation	84%
No poverty	86%
Quality education	84%
Average	**77%**

North America

Industry, innovation	90%
Good health	85%
Sustainable cities	85%
Decent work	85%
Life on land	85%
No poverty	83%
Average	**71%**

Q6a: Which of the SDGs are included in your city's plans and on which of them has your city made considerable progress?

SDG sprinters take five key steps to ensure success

More than nine out of 10 sprinter cities monitor their SDG progress and 58% conduct voluntary local reviews.

In addition, 72% of sprinters assess their SDG performance against other cities.

SDG programs do well when they have the backing of different parts of the government, which is the case with 86% of sprinters.

Another best practice is to assign a department to lead the SDG efforts, followed by more than three-quarters of sprinters.

Five steps to SDG sprinter success

Monitor progress

94% regularly monitor SDG progress vs. **70%** of other cities. Only **12%** of implementers track progress.

Select a department to lead

78% have a department that leads SDG efforts vs. only **46%** of other cities and none of the implementers.

Conduct a voluntary local review

58% have done voluntary local reviews of SDG progress vs. only **40%** of other cities.

Gain wide support

86% enjoy wide support across city government, including high levels, vs. **57%** of other cities.

Assess results against peers

72% measure SDG progress against peers to identify strengths and weaknesses vs. **40%** of other cities.

"Cities are about people, not gadgets. We should be mindful of diversity, equity, and inclusion to ensure that any techniques or technology are based on improving quality of life for all."

Karen Lightman, Executive Director, Metro21: Smart Cities Institute, Carnegie Mellon University

Q6b: Which of the following statements about your city's adoption of the SDGs do you agree with?

Cities will face headwinds over the next three years

Half of cities believe complex policies and difficulty in finding the right partner or supplier will bog down their SDG efforts.

These hurdles are most acute in the Middle East, where fragmented policies and the scarcity of local top-tier suppliers can stymie SDG efforts. Other top impediments include data security and privacy, the fast pace of digital change, and the need to provide basic services—a particular pain point during the pandemic.

The prevalence of these SDG hurdles depends partly on a city's level of economic development. Cities in advanced countries more often face problems relating to policies, suppliers, and data security and privacy. Emerging market cities suffer more from high costs, budget constraints, and weak economic conditions, as well as insufficient support from both the government and citizens. These barriers are most pronounced in African cities.

"Many cities can learn from leaders like New York, Copenhagen, London, and Singapore but they must realize that adaptations must be context specific—it is important for the 'model' cities to reveal the conditions that allowed them to undertake their innovations and equally important for the adapting city to understand its own conditions—not to adopt something without adapting it."

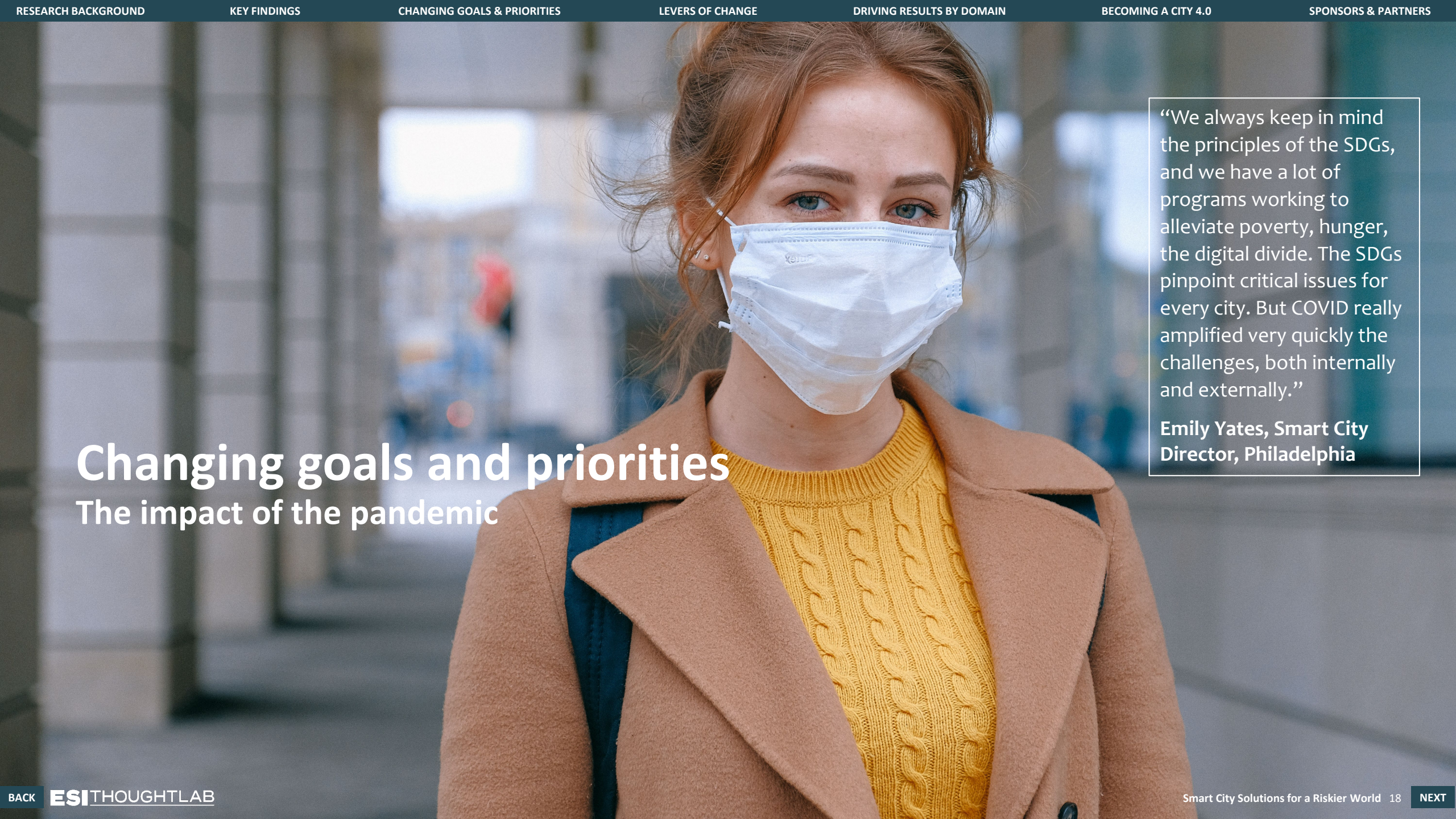
Eugenie L. Birch, Nussdorf Professor and Co-director, Penn IUR

Top 5 challenges

1. **52%** Complex policies and regulations
2. **50%** Finding the right partner or supplier
3. **44%** Data security and privacy
4. **37%** Fast pace of technological change
5. **30%** Need to focus on basic services

Challenges: Emerging vs. advanced markets

Q7: What are the main challenges that your city faces in achieving its social, environmental, and economic goals over the next three years?



Changing goals and priorities

The impact of the pandemic

> "We always keep in mind the principles of the SDGs, and we have a lot of programs working to alleviate poverty, hunger, the digital divide. The SDGs pinpoint critical issues for every city. But COVID really amplified very quickly the challenges, both internally and externally."
>
> **Emily Yates, Smart City Director, Philadelphia**

The pandemic was a watershed event

COVID-19 was by far the biggest upheaval that cities faced in recent memory. Every region ranked it as the top disruption in 2020, except for Africa, where it was tied with declining economic growth, an offshoot of the crisis.

On average, 81% of cities said the pandemic was a major disruption. It was even more troubling for cities in advanced markets, such as North America (98% of cities) and Europe (92%), which struggled to contain the virus. Declining economic growth and rising digital expectations—both repercussions of the pandemic—came in a distant second and third. Other challenges, such as climate change, resource constraints, shifting demographics, and social unrest paled in comparison.

Even after the pandemic ends, the shockwaves will persist. Over two-thirds of cities will reconsider urban planning and use of space and 54% will rethink mobility. Strikingly, over half of urban leaders believe the crisis will forever alter how people, live, work, socialize, and travel in cities.

The impacts vary by region. Over nine out of 10 cities in Latin America will reconsider urban planning and use of space. Eight out of 10 cities in the Middle East plan to re-examine their mobility and transportation approaches. And 68% of cities in Europe expect the way people live, work, and travel to permanently change.

> "The pandemic has taught us both low-tech and high-tech lessons. It has laid bare issues of social and economic vulnerability, increasing our focus on public health, diversity, and inclusion. It has underscored the importance of a city's social fabric; the seemingly intangible benefits of a neighborhood—and neighbors—are now strikingly tangible."
>
> **Jarendra Reddy, Director, Urban Solutions, Hatch**

Top external disruptions

81%
Pandemic and its repercussions

46%
Decline in economic growth

28%
Rising digital expectations of citizens

25%
Climate change

23%
Lack of resources

18%
Shifting demographics and diversity

18%
Social unrest

The pandemic's lasting impacts

69% Reconsider urban planning & use of space

54% Rethink mobility & transportation

54% Accelerate the shift to online healthcare

53% Permanently change how people live, work, socialize, & travel in cities

36% Expose the weaknesses in cities' operational continuity capabilities

Q8: Please select the top three external disruptions facing your city today. Q9: Which of the following statements about the impact of COVID-19 on your city and its stakeholders do you agree with?

The pandemic heightened the SDG imperative

The pandemic made the social good a higher priority for more than one-third of cities around the world. The number is even higher in Europe, where it has prompted 43% of cities to do further soul searching.

The health crisis elevated the importance of the SDGs for over a quarter of cities surveyed. Cities in developed markets were almost 2.5 times as likely as those in emerging economies to give the SDGs higher priority as a result of the pandemic.

For 14% of cities, social distancing and other containment measures have generated environmental benefits that they will strive to maintain. African cities, for example, saw improvements in biodiversity conservation, which 26% of them hope to sustain after the pandemic ends.

SDG programs have helped nearly one out of five cities cope with the pandemic and these cities will use them as a platform for recovery. Partnerships with the private and public sector, for example, helped municipalities weather the storm. For cities in developed countries, the percentage that benefited from the SDGs was even higher—25%.

"The pandemic will upturn traditional urban development models and compel cities to reimagine mobility, health infrastructure, housing, education, energy consumption, and more. It has laid bare the inequities in access and has impacted disadvantaged communities more. Along with inclusion, addressing these systemic inequities in the current urban development model will be critical for cities."

Michael Flynn, Global Government & Public Services Financial Advisory Leader, Deloitte

Pandemic impacts

36%
The pandemic has stimulated new thinking about our priorities to build the social good.

28%
The COVID-19 health crisis has made the SDGs a higher priority for our city.

18%
Our SDG program has helped our city to respond to the COVID-19 pandemic.

14%
The pandemic has led to environmental benefits that our city is striving to maintain.

Q6b: Which of the following statements about your city's adoption of the SDGs do you agree with? Q9: Which of the following statements about the impact of COVID-19 on your city and its stakeholders do you agree with? Q10: What were the biggest lessons learned from the pandemic?

COVID-19 highlighted the value of smart city programs

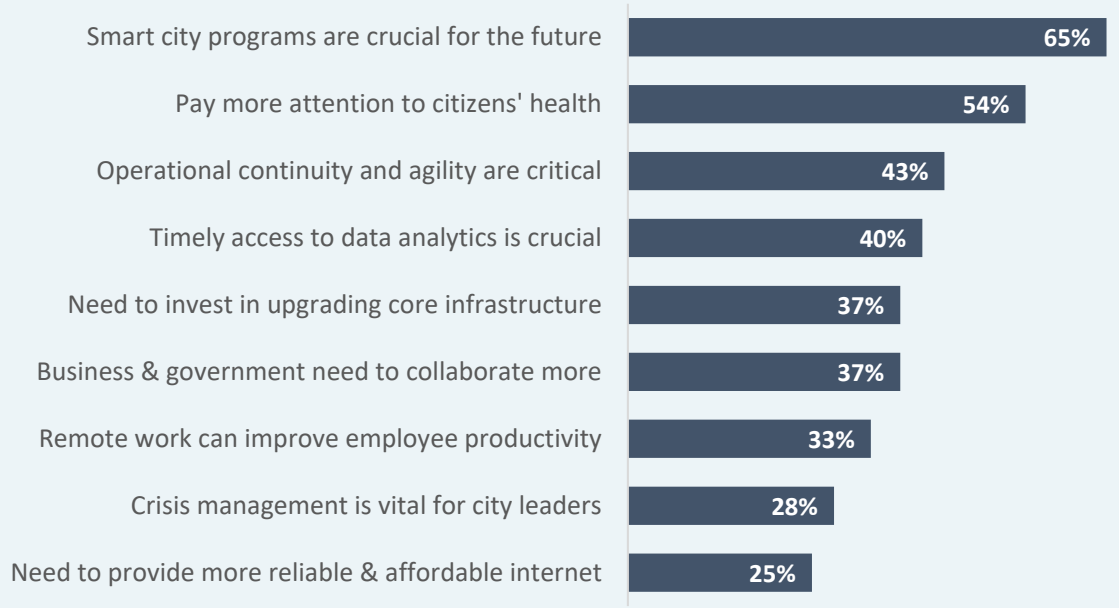
With social distancing preventing physical interaction in cities, smart technology became the only game in town.

For 65% of cities, the biggest lesson learned during the pandemic was just how crucial smart city programs were for their future. This was a particularly critical lesson for cities in the Middle East (80%) and Europe (68%). Also, 43% learned the importance of operational continuity and agility, and about the same percentage realized the merit of timely access to data and analytics.

The pandemic also drove home the need to work differently. Almost four out of 10 cities learned the value of collaboration between the public and private sectors to address today's issues. About a third found that remote working could boost staff productivity, while 28% learned that crisis management was vital for city leaders and workers to cope with unexpected disruptions.

COVID-19 also convinced cities of the need to invest more in upgrading core infrastructure (37%) and in reliable and affordable connectivity (25%).

Smart city lessons learned during the pandemic



"Technology enables SDG progress because it can integrate both technical and social solutions. It optimizes use of scarce resources, connects governments with their citizens, and scales quickly to respond to dynamically changing conditions. Further, it enables both front-end insights and feedback loops that power a cycle of continuous improvement."

Andrew Caruso, Director, Strategy and Operations, Urban Solutions, Hatch

Q10: What were the biggest lessons learned from the pandemic?

But the pandemic also underscored the need for cybersecurity

Smart city innovation is a double-edged sword. As cities increase their investments in digital technologies, they also expose their cities to greater risks if they do not put safeguards in place up front.

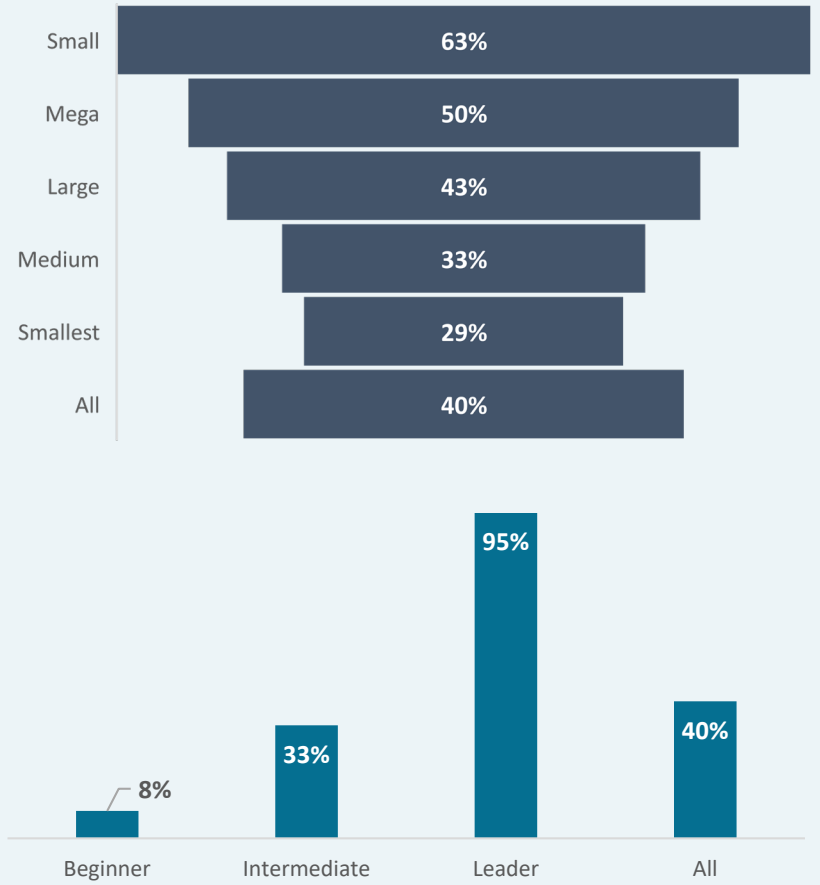
The pandemic was a stress test for urban cybersecurity systems. Attacks on state and local governments went up dramatically as cybercriminals sought to take advantage of the crisis.

Many cities fell victim to ransomware and other attack vectors. For example, Knoxville, TN was hit in June of 2020 with an attack that crippled its IT systems. The disruption escalated when hackers began publishing data online in a move to extract a ransom payment. Hackers also took advantage of pandemic-related disarray by shamelessly targeting some hospitals.

Our study shows that cities need to do more to keep their urban centers and citizens secure. Most cities, 60%, report they are not well prepared for cyberattacks. Although small cities feel more confident about their cybersecurity systems than others, the smallest urban areas are in a more precarious situation, with only 29% reporting they are well prepared. This is borne out by the number of smaller cities in the US, for example, that were attacked during the pandemic (including Florence, AL, Pensacola, FL, and Torrance, CA).

In fact, one sign of a smart city leader is their level of cybersecurity—95% are well prepared for cyberattacks against just 8% of beginners.

% of cities that are well/very well prepared for cyberattacks by size and smart city maturity



Q25: How prepared is your city for cyberattacks?

Where smart city leaders invest more in cybersecurity

City managers should take a sheet from the lesson book of smart city leaders.

There are five key cybersecurity steps that leaders take far more often than other cities to address their cybersecurity vulnerabilities.

1. **Prioritize assets and create access control policies.** Protecting a city's most valuable assets is a smart first step, as is making sure the city imposes tight controls on who can access systems.
2. **Invest in disaster recovery, response, and event management technology.** No matter how strong a city's firewalls, it only takes one bad guy to get through. So smart city leaders invest more heavily in specialized recovery and response technology to act quickly to mitigate impacts.
3. **Provide cybersecurity training to staff.** This is a critical step for cities since cybercriminals often capitalize on employees' mistakes.
4. **Protect critical infrastructure.** This includes security testing of electricity grids, traffic lights, hospitals, and other urban assets. Interconnecting city assets and domains through IoT and other technologies can expose cities to a catastrophic attack if they do not adequately safeguard their infrastructure.
5. **Develop a cyber incident response and recovery plan.** Smart city leaders understand they not only need to be act quickly to stop an attack, but also have processes in place to limit the aftereffects, including those related to liability, and financial and reputational impacts.

Areas where smart city leaders invest more

	Leader	All	Difference
Prioritize assets & create access control policies	68%	49%	19%
Disaster recovery, response, & event management technology	46%	31%	15%
Cybersecurity training for staff	54%	40%	14%
Protect critical infrastructure, including security testing	49%	35%	14%
Develop incident response & recovery plan	43%	29%	14%
Augment staff with outside specialists or outsourced functions	32%	23%	9%
End-point security, such as securing mobile devices & laptops	19%	12%	7%
Cloud & network security	70%	65%	5%
Hire more cybersecurity specialists & staff	78%	76%	2%

"Resilience and agility are a must to survive and to thrive. Governments move at a slower pace because we have fiduciary responsibility. We have oversight by our elected officials and the public. We don't have the luxury of time. It's not if, it's when we'll have another crisis, and it's all about creating a state of readiness."

Aram Chaparyan, City Manager, City of Torrance

Q26. In which cybersecurity areas is your city planning to make large investments of money and time over the next three years?

"The SDGs are seen as a strategy for communities to tie a global framework with important local urban challenges that we're facing around housing, affordability, homelessness, climate change, and many others."

Chris Castro, Director of Sustainability and Resilience, City of Orlando

Levers of change

Driving results through five levers of change

Our economists created an analytical framework to examine how 167 cities apply a variety of change drivers across urban domains to advance sustainability, economic growth, social change, and citizen well-being.

The importance of these levers of change became apparent during the pandemic. To cope with the health crisis, cities relied on partnerships, digital technology, data analytics, and new funding models to get things done. Proactive governance and leadership helped cities keep citizens safe and businesses intact.

Five levers of change

1. Partnerships and ecosystems
How cities work with citizens, businesses, universities, NGOs, and others to achieve the SDGs.

2. Finance and business models
Financing and business models that cities use to pay for needed investments.

3. Digital technology
The use of digital technology to drive operational, social, environmental, and economic improvements.

4. Data management and analytics
How cities manage data and analytics to support their smart, sustainable practices.

5. Governance, leadership, and vision
How cities govern and manage their SDG programs and engage with stakeholders.

While many cities have smart city initiatives, transforming aspirations into implementation can be challenging, especially for cities with limited fiscal and technical capacity in emerging markets. A lot of work needs to be done to develop projects to be commercially viable. Cities can better implement their smart city goals by working with development partners that understand what it takes and can support this journey.

Lisa Da Silva, Global Cities Lead, International Finance Corporation

1. Partnerships: SDG sprinters leverage their ecosystems

By working with the private sector during the crisis, urban leaders were better equipped to keep citizens safe and their cities operational. It sent a powerful message to the world.

The pandemic was a painful learning experience: for 47% of sustainability sprinters, the need for businesses and government to collaborate was a clear lesson. Also, 25% of sprinters learned that a resilient ecosystem of partners and suppliers is vital for coping with disruptive events.

Sprinters work with a range of partners to achieve their results. They are twice as likely as others to team up with financial institutions and academic and research institutions. They also work more with community groups, NGOs, foundations, and industry and trade associations.

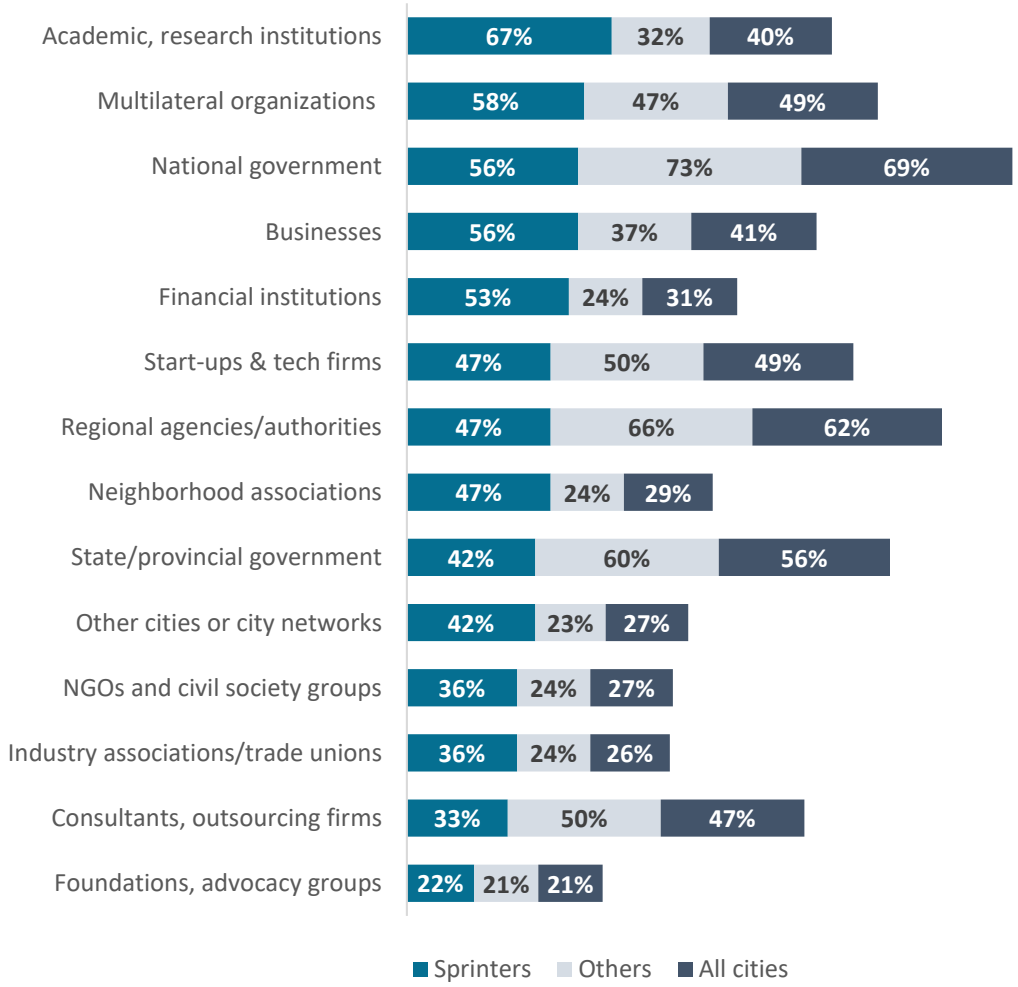
SDG sprinters have a different approach to the public sector than cities in earlier stages of sustainability development. They are more apt to draw on multilateral organizations and collaborate with other cities. SDG implementers and advancers are much more likely to look to national, state, and regional groups for support.

How Trondheim works with academia

Taking advantage of its proximity to the Norwegian University of Science and Technology (NTNU), the city of Trondheim has recruited volunteers and students interested in sustainability to conduct research and suggest smart solutions. In the city of 200,000 people, over 4,000 students work on these initiatives each year. The city also has created innovation boards that bring together university directors and deans to discuss the latest sustainability strategies. NTNU's artificial intelligence center, the Norwegian AI Lab, also works closely with the city. AI technology can provide essential data insights enabling cities to improve infrastructure, mobility, sanitation, public security, and the environment.

"We are quite systematic in how we work across institutions. With the university-city agreement, we tried to align the governance system within the city and within the university. We can give the students and scientists easier access to the city, and insights into the problems we are having, and we can also bring new knowledge faster into the way we run the city," said Øyvind Tanum, Head of Smart City, Trondheim.

Partnership priorities over next three years



Q13: Considering your city's experience with the pandemic, which of the following partnerships will your city prioritize over the next three years?

1. Partnerships: Cities want smart, secure, sustainable solutions

Cities are blazing a trail on achieving the SDGs—and expect their partners to do their part as well.

Seventy-eight percent of cities cite sustainability and resilience as a priority when choosing a partner. For cities just starting to adopt the SDGs, smaller cities, and cities in Africa and Latin America it is the top criterion.

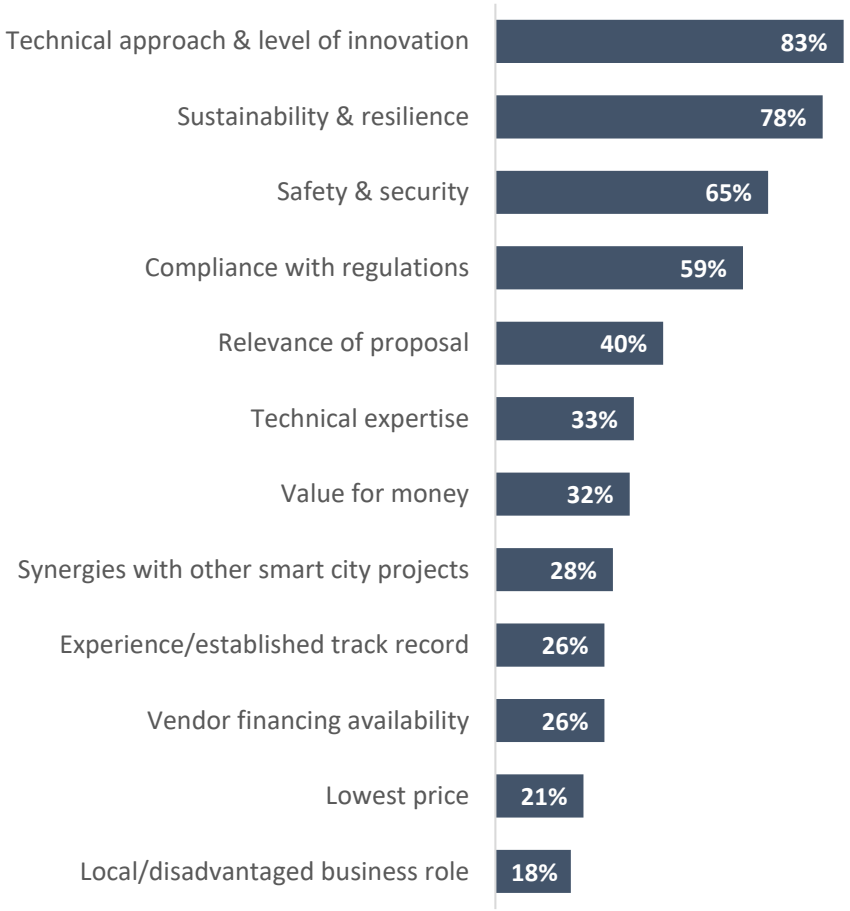
In addition, cities want their partners to offer solutions that enable a high level of innovation (83%) while also ensuring safety and security (65%). Sprinters (92%), North American cities (92%), and European cities (92%) value innovation the most.

Price is not top of mind for most cities when evaluating smart city proposals—it is cited by only 21% of them. Cities just beginning to make progress on the SDGs (41%) and those in Africa (47%) are more cost conscious than their counterparts in other regions.

SDG sprinters are three times as likely as implementers to use the smart city proposal process to help achieve social goals by including the participation of local and disadvantaged populations in evaluating partners (28% of sprinters vs. 6% of implementers).

> "The first tool that cities should leverage is a culture of collaboration. If the pandemic has taught us anything, it has revealed that no one person, stakeholder, or department in government has all the answers to solve all the needs of the community."
>
> **Kevin Taylor, Segment Development Manager, Smart Cities, Axis Communications**

Criteria to evaluate partners over next three years



Q12: What criteria will be most important to your city when evaluating smart city proposals over the next three years?

2. Funding: Finding new sources of financial support

Funding for the SDGs is a major challenge: the financing gap in the emerging markets alone is estimated to be $2.5 trillion to $3.0 trillion per year, according to the UN.*

Given their central role in achieving the SDGs, cities will bear a large portion of the funding burden. This will require them to find new sources of financial support.

Today, cities rely on private-sector financing, government-based borrowing, funding from national and state governments, and user fees and taxes to pay for their social, environmental, and economic programs. Over the next three years, these mechanisms will decline in usage.

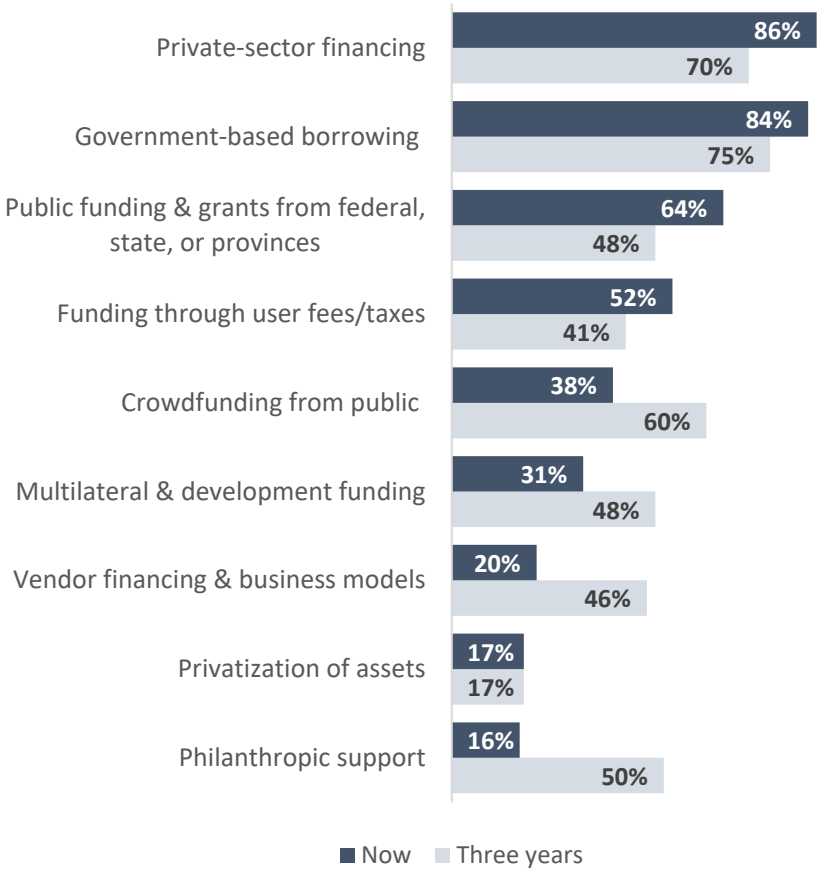
In their place, cities will draw more heavily on philanthropic support, vendor financing, crowdfunding, and multilateral and development funding. For example, in Asian cities, such as China and Japan, philanthropy has long been a source of funding for the public good. But the practice is spreading around the world as business leaders embrace the SDGs.

Today, SDG sprinters mostly tap government-based borrowing, private-sector financing, public funding and grants, and user fees and taxes. In three years, they will turn more to crowdfunding, government-based borrowing, private-sector financing, and vendor financing and business models. Public-private partnerships likely will be one key means to draw in private-sector financing.

Top funding mechanisms used by sprinters

Today	3 years
Government-based borrowing 94%	Crowdfunding from public 81%
Private-sector financing 83%	Government-based borrowing 75%
Public funding, grants 61%	Private-sector financing 67%
Funding through user fees, taxes 61%	Vendor financing & business models 64%

Main funding techniques to support SDGs



Q15: Please select the main financing/funding techniques that your city now uses/will use to achieve your social, environmental, and economic goals. * Roadmap for Financing the 2030 Agenda for Sustainable Development.

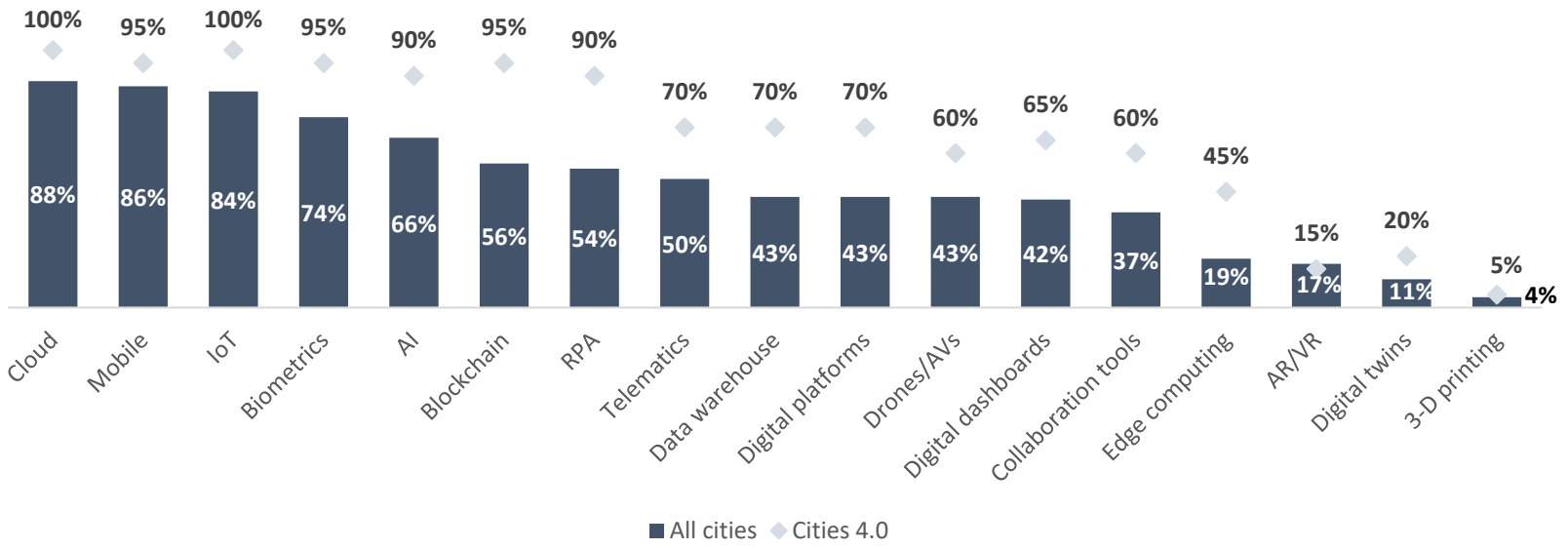
3. Technology: Placing the right bets

Cities are adopting a wide array of smart technologies, especially cloud, mobile, IoT, biometrics, and AI.

Cities 4.0 are moving even faster to leverage advanced technologies: 100% have made hefty investments in cloud and IoT, and slightly fewer are spending significantly on mobile, biometrics, blockchain, AI, and RPA.

Over the next three years, cities plan to increase investments significantly in digital twins, 3-D printing (off a an extremely small base), data warehouses, augmented and virtual reality, blockchain, digital dashboards, and drones. The share of cities making large investments will jump the most for digital twins, from 11% today to 31% in three years—a rise of almost 300%. For Cities 4.0, the increase in digital twins will be even greater, from 20% today to 70% in three years.

% of cities making large investments today



% increase in cities making large investments over next 3 years

- 282% **Digital twins**
- 200% **3-D printing**
- 149% **Data warehouse/ lakes**
- 147% **AR/VR**
- 127% **Blockchain**
- 126% **Digital dashboards**
- 126% **Drones, AVs**
- 124% **Telematics/ geospatial**
- 121% **AI**
- 119% **Online collaborative tools**

> "Smart technology, data, and analytics will need to be translated into new sustainable economic and environmental policies. AI and analytics-based solutions providing real-time and predictive information will be key alongside having better data and multiple data sources."
>
> **William Baver, Vice President, Smart Platform, NTT**

Q16: In which of the following digital technologies and solutions has your city made large investments and in which will you make large investments over the next three years?

3. Technology: Cities are getting smarter through AI and the cloud

Sixty-six percent of cities are investing heavily in AI and 80% will do so over the next three years. North American (83%) and small cities (74%) lead in AI use. Over the next three years, European cities (97%) will surpass North American cities (88%) in AI investments.

For cities adopting AI, machine learning and digital assistants/chatbots are table stakes, used by seven out of ten cities and nearly eight out of 10 sprinters. Computer vision is gaining ground, while use of deep learning and natural language processing is still relatively nascent.

While nearly every city uses the cloud (88%), how they use it varies. Ninety percent use a public cloud based in their home country and 82% use a private cloud. One thing is clear: cities prefer that their data stay within their national borders—only 23% use a public cloud outside of their country and over 60% are not permitted to use a public cloud outside of their country.

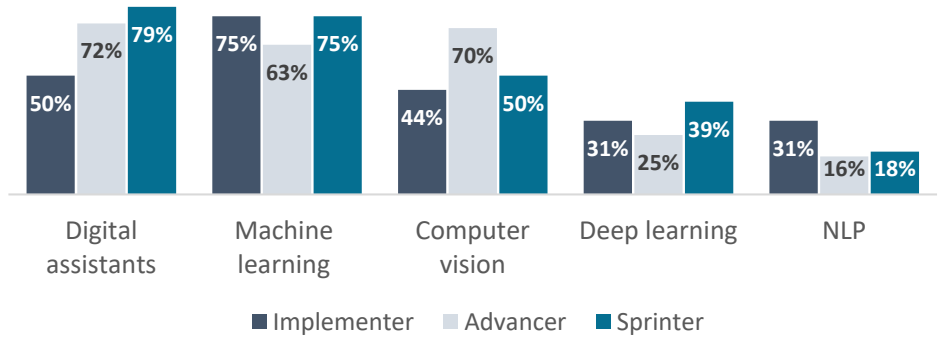
Using one type of cloud is not enough. To achieve their goals, cities need to become omni-cloud, combining multiple formations—69% of sprinters use multi-clouds and 81% use hybrid clouds.

Sprinters also prefer to have control. Eighty-nine percent prefer to deploy their smart city solutions "on premise" in their own data center and 83% prefer to use a private cloud server.

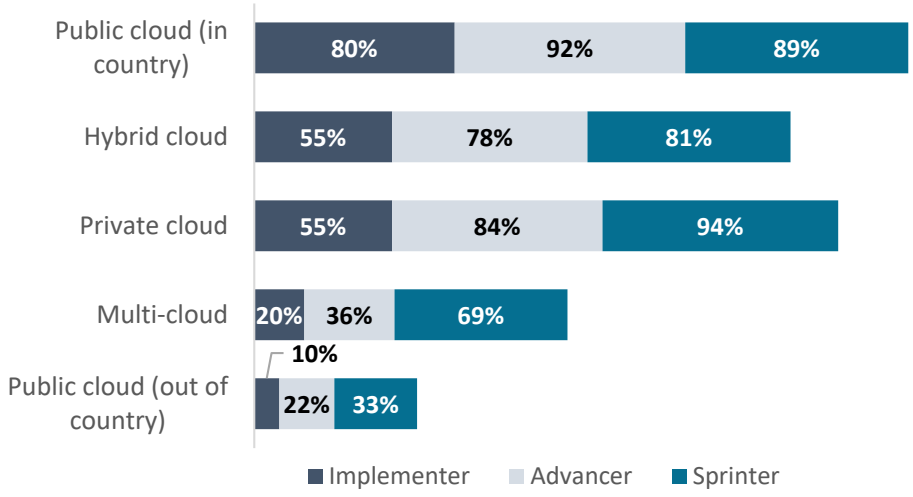
How Philadelphia is using AI to improve the streets

AI has proved useful to Philadelphia as it seeks to improve the quality of its streets. It partnered with a start-up that provides a low-cost imaging device that takes images every half second, 30 feet wide, and uses AI and visual ML to assess the quality of the pavements—one of the top complaints of citizens in the city. The project covered 1,200 miles of pavement in three months and led to the development of a five-year pavement strategy. Fixing pavements contributes to better social equity, as well. For example, if public transportation rides on smoother streets, maintenance costs are reduced as is the need to raise transit fares. The partner company also now is training its AI to map manhole locations and street signs.

Types of AI usage



Cloud deployments by SDG progress



Q16, 16a, and 16b: Which of the following technologies has your city made large investments in, and in which will you make large investments over the next three years? What types of AI technologies is your city using? What types of cloud is your city using to deploy your smart city solutions?

4. Data: SDG sprinters leverage diverse data sets

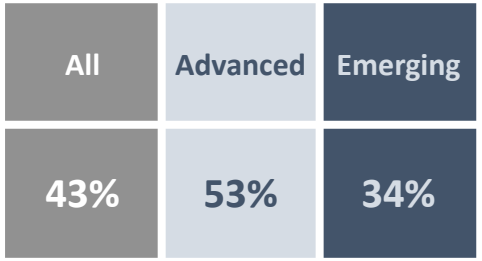
Timely access to data is vital for running today's cities, according to 40% of urban leaders. That is why they will use multiple types of data in the future.

On average, cities today use six different types of data and in three years they will be using seven. SDG sprinters already use an average of seven types of data, and this will increase to nine. Administrative, IoT, and citizen usage and satisfaction data are the main types of data used now. While predictive, peer-based, channel-usage, and geospatial data are tapped less frequently, they are slated for a meteoric rise over the next three years.

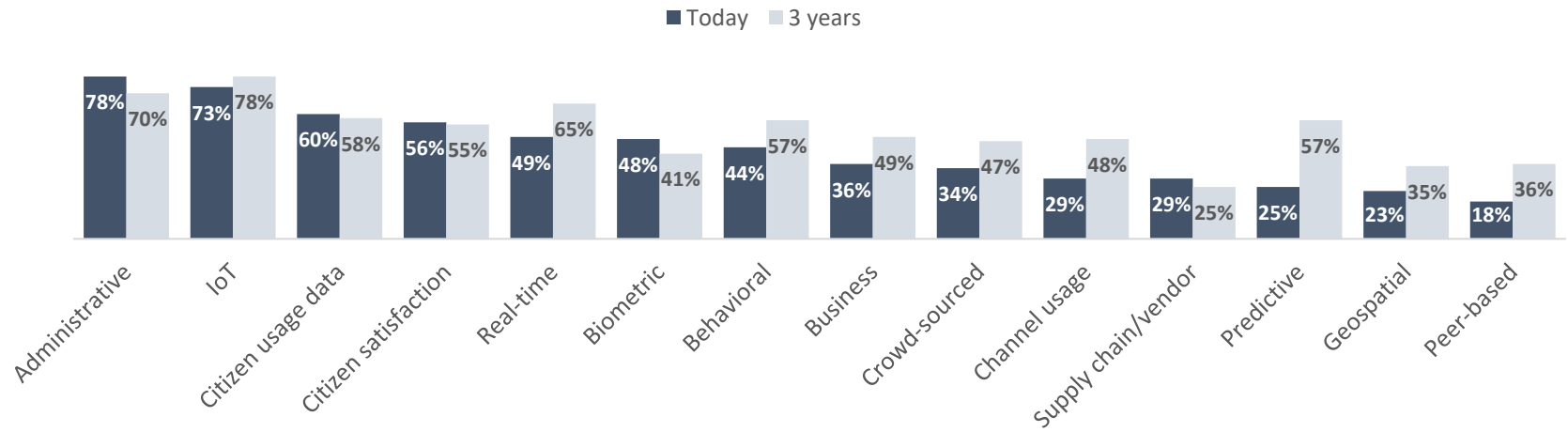
Although biometric data was beneficial during the pandemic—particularly in preserving workplace safety—many cities expect to moderate its use in the future. One reason is rising concerns that biometric surveillance could infringe on civil rights. With resistance growing in the Middle East and North America, use of biometrics is expected to decrease 50% and 23%, respectively, in those regions. Latin America will be the only region to bump up its use of biometrics, by 21%. Governments there see it as a tool to combat terrorism, crime, and fraud.

There are biometrics use cases that are more acceptable: 43% of citizens across cities have a positive view of facial recognition tools to improve security. Cities in advanced markets see it more favorably than those in emerging markets.

% having positive view of facial recognition to improve security



Types of data used today vs. next 3 years



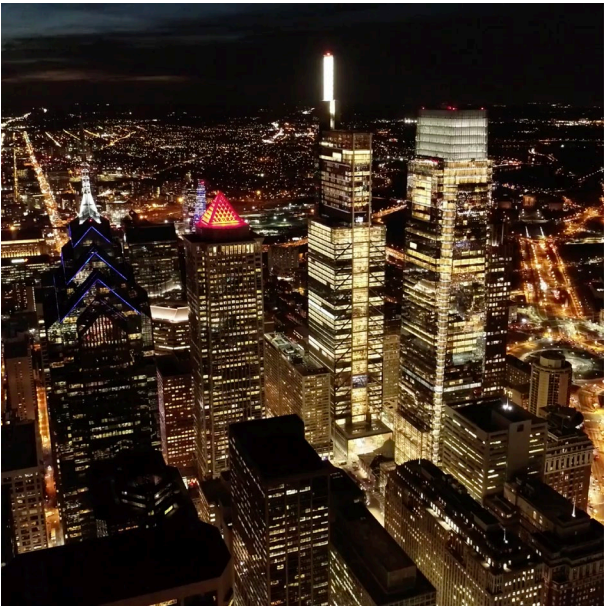
Q22: Which of the following types of data does your city actively use to support its operations, and which will your city actively use in the next three years?
Q24: What is the general sentiment of citizens regarding the following uses of data and technology, given their perceived benefits and drawbacks?

4. Data: SDGs sprinters drive greater value from data

Sustainability sprinters are well ahead of others in the effective use of data analytics.

Sprinters have made the most progress in collecting data, integrating multiple types of data, and making data accessible, both internally and externally. They are far ahead in analyzing and extracting value from that data, as well as in predicting trends from data and ensuring data quality.

Nearly half of all cities and 64% of sprinters are advanced in monetizing data. However, many citizens have qualms. Less than 30% of citizens have a positive view of the sale of personal data to support city budgets, and the percentage is surprisingly even lower for impersonal data. Citizens living in Cities 4.0 are slightly more positive: 35% and 32%, respectively, have a favorable view of selling personal or impersonal data.

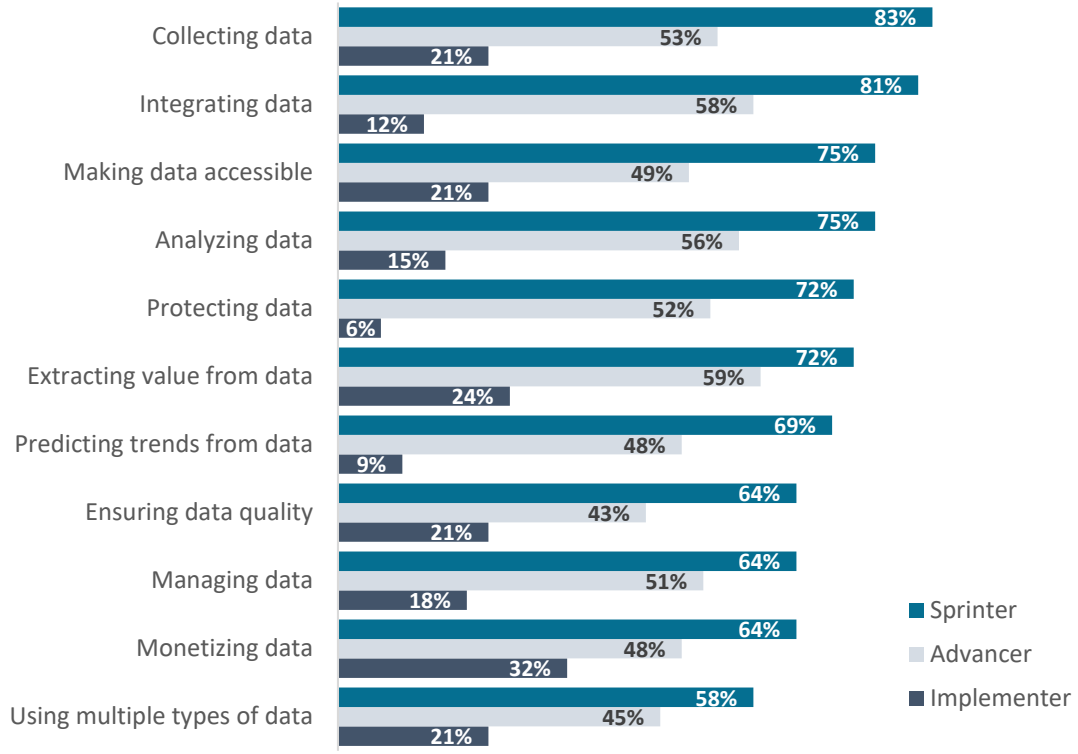


How Philadelphia used data to cope with the pandemic

Access to data proved crucial during the pandemic. Philadelphia, for example, manages more than 250 publicly available data sets for tasks as varied as parking violations and commodities contracts. With centralized data and internal APIs, the city's CIO and IT team were able to build analytics dashboards with visualization features to give city workers easy access to data. This work proved very valuable during the crisis, when data availability was critical. When COVID-19 forced city personnel to work from home, the IT team was able to keep both citizen services and digital initiatives running smoothly.

Maturity stages in data analytics

(% maturing or leading)



% having a positive view

	All	Advanced markets
Sale of personal data to raise funds	29%	35%
Sale of impersonal data to raise funds	22%	32%

Q23: Please tell us your city's maturity stage in the following areas of data analytics. Q24: What is the general sentiment of citizens regarding the following uses of data and technology, given their perceived benefits and drawbacks?

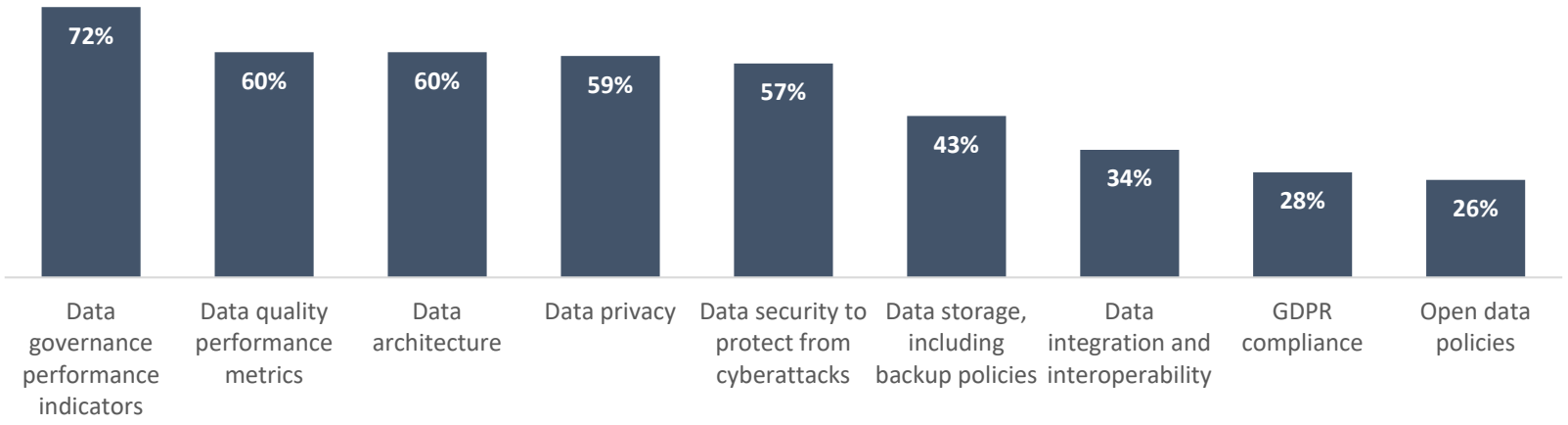
4. Data: Governance is key

Data management is central to smart city success. However, only 35% of cities (47% of sprinters) have a written policy that ensures the responsible management of data and only 39% (47% of sprinters) ensure there is an appropriate budget for data management.

By not managing data responsibly, cities can leave significant value on the table. It also may result in a public backlash that can undermine a project. Concerns about data management was one issue that plagued the Sidewalk Labs Toronto Project. Citizens wondered what data would be collected, how it would be collected and used, and how potential breaches would be handled.

An effective data governance policy should address the nine components noted below. Cities overall are doing a decent job of incorporating performance indicators and quality performance metrics, defining data architecture, and addressing data privacy and security concerns. But they need to significantly improve open data policies, GDPR compliance, and data integration.

Data policy coverage



"We created an open data model called GAQO, for Governance, Administration, Quality and Optimization of data. It's important to make data open, available, and useful to people. GAQO ensures that no data is wasted and that we use it to satisfy the need for information and to solve issues. This model generates value for the government, enabling us to improve products and services."

Grace Quintana, Leader in Digital Transformation, Government of Bogota

Q21 and Q21a: Which of the following statements on data management do you agree with? Which of the following areas are covered in your data management policy?

5. Governance, leadership, and vision

The use of technology and data alone is not enough. If cities are to achieve their objectives it is essential that they have an effective governance framework in place.

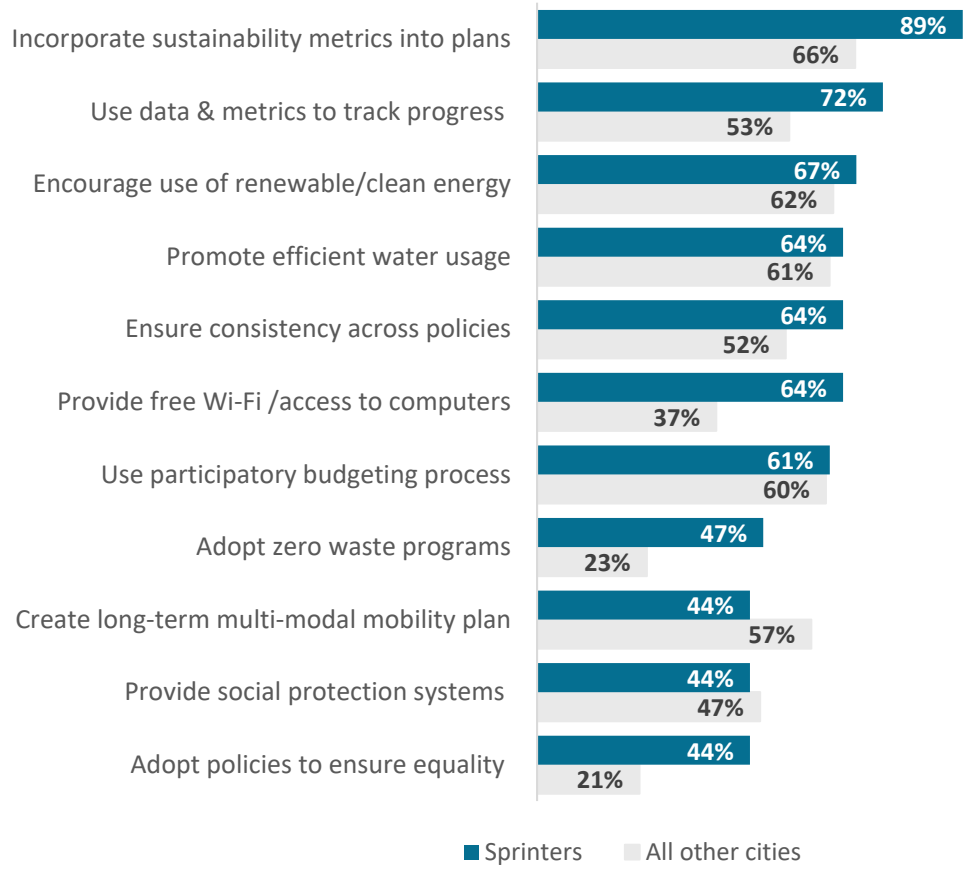
The framework will help boost the implementation of necessary policies through urban planning actions, ensuring appropriate technology investments to achieve the goals, and identifying the key performance indicators (KPIs)/metrics required to support evidence-based decision-making.

Cities vary in the approaches they take to govern and manage their smart city programs based on the specific challenges they face. Sprinters take an approach that includes a mix of overarching governance steps (such as incorporating sustainability metrics in the planning process, and ensuring consistency across social, environmental, and economic policies) as well as domain specific steps (such as encouraging the use of renewable energy and promoting efficient water usage).

"Three important factors differentiate advanced, Cities 4.0: a shared vision, which is developed with deep stakeholder engagement and brought to reality by strong, execution-focused leadership. Instead of siloed approaches, these cities take a more integrated view to create improvements across a range of functional areas."

Aseem Joshi, General Manager of Smart Cities, Honeywell

Top governance steps taken by cities



5. Governance: Citizen engagement is critical

Effective governance requires transparency, accountability, collaboration—involving all stakeholders—and the participation of citizens.

Citizen engagement is a two-way process between the public and local government. Studies indicate that cities with high levels of participation have stronger communities and more empowered citizens, offer better services, and are better equipped to achieve their social, environmental, and economic goals.

The upheaval caused by the pandemic required decisions to be made in a quick and inclusive manner. This highlighted the need for greater real-time feedback from citizens.

Yet citizens often are reluctant to participate in the process. Sprinters use a variety of techniques to overcome this reluctance. They use a mix of digital and traditional engagement methods, ensure that disadvantaged populations are actively involved, encourage participation through gamification and other incentives, and proactively demonstrate the value of projects to stakeholders.

How cities engage citizens

	Sprinter	Advancer	Implementer
Communicate through digital & traditional methods	86%	73%	56%
Offer citizens a digital platform to address needs	69%	63%	50%
Ensure disadvantaged populations are involved	67%	47%	35%
Use gamification to increase citizen participation	64%	48%	21%
Actively engage stakeholders to set priorities	61%	47%	41%
Proactively demonstrate value to stakeholders	58%	49%	29%
Have appointed chief citizen experience officer	22%	12%	0%

How Orlando has mobilized the public to achieve the SDGs

When Orlando, a sprinter city, began to incorporate the SDGs into its planning process, it first undertook an effort to meaningfully educate the community about what the SDGs are and how they tie into the city's local priorities. The city also worked with a local nonprofit NGO, Ideas for Us, to host a monthly community engagement forum—the Ideas Hive Workshop. Each month it chooses a global goal and brings in a subject matter expert to educate the community. In breakout sessions, citizens suggest local solutions to help achieve these global goals.

Q29: Which steps does your city take to foster citizen engagement?

5. Governance: Implementation starts with a clear plan and roadmap

Cities take a range of steps to decide which projects to undertake to achieve their social, environmental, and economic goals. Creating clear implementation plans is a critical starting point.

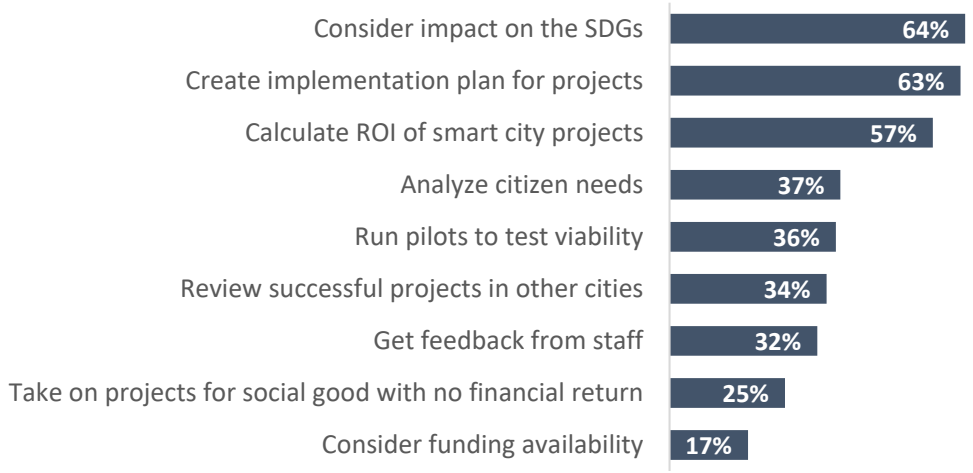
When deciding which projects to implement, 64% of cities consider the impact the project will have on their SDGs and 63% create a business and implementation plan. Fifty-seven percent calculate a project's ROI. Understanding costs and benefits is key but is often missing from many cities' analysis.

Fewer than four out of 10 cities consider the needs of both citizens and employees when making project decisions. This is one area where sprinters stand out, with about half considering their stakeholders' needs before they act. This may also explain why only 8% of sprinters cite lack of citizen support as one of the main challenges they face in achieving their goals.

Thirty-six percent of cities run pilots to test viability and 34% examine projects that were successful in other cities. Less than 20% consider funding availability when deciding which projects to pursue.

> "Bogota has followed a very structured path. We have a national roadmap that leads the planning of all initiatives related to smart cities. The roadmap starts with a self-diagnosis that details the current capacities of the city, followed by a projection of what we can reach."
>
> **Grace Quintana, Leader in Digital Transformation, Government of Bogota**

How cities decide which projects to implement



Where sprinters stand out

	Sprinters	All
Get feedback from staff	47%	32%
Analyze citizen needs	53%	37%

Q27 and Q27a: How does your city decide which projects to implement to achieve your urban goals? When calculating the ROI, to what degree do you quantify the following benefits?

5. Governance: Look to SDG sprinters for ROI best practice

When calculating ROI, sprinters excel at capturing the full range of benefits generated by the project.

Sprinters understand that projects that generate good social and environmental outcomes can also have knock-on economic and financial benefits. Nearly nine out of 10 sprinters include environmental benefits in their ROI calculations and 76% incorporate social benefits. The percentages are considerably lower for SDG implementers.

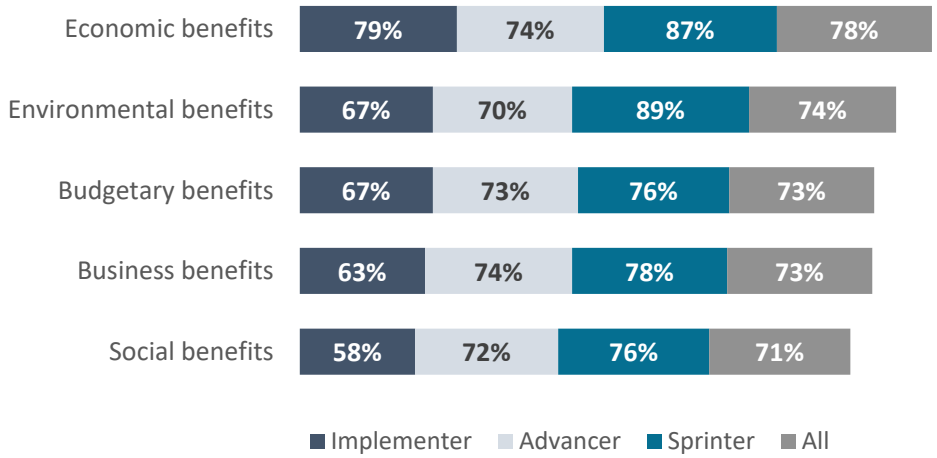
Sprinters also understand that ROI, while important, is not the be-all and end-all. More than one-third will undertake a project that achieves a greater social goal, even if it generates a negative economic or financial return.

Most cities take the full range of economic, business, budgetary, environmental, and social benefits into account when measuring ROI. Understanding any associated costs and risks also is important.

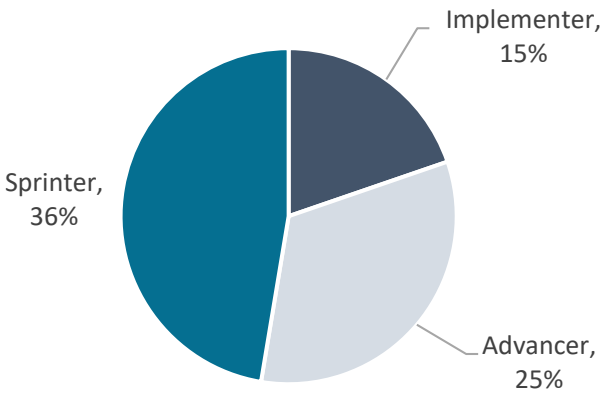
"When looking to achieve their sustainability goals, cities need to consider both the monetary and non-monetary benefits. The goal is to generate a real return, but also to create an impact on the wider society and on citizens' lives. It is key for cities to have a long-term view that goes beyond the current situation. With a focus only on short-term monetary results it will be easier to fail and focus on the wrong metrics."

William Baver, Vice President, Smart Platform, NTT

Benefits quantified when calculating ROI



Our city undertakes projects that generate a greater social good, but no direct economic or financial benefit.



Q27 and Q27a: How does your city decide which projects to implement to achieve your urban goals? When calculating the ROI, to what degree do you quantify the following benefits?

"Our work on sustainability is not rocket science. There is a business case. The city is a good laboratory for testing and is making a huge effort to be an example and show the private sector what is possible."

Filipe Araujo, Vice Mayor, City of Porto

Driving results by domain

Progressing across eight urban domains

Our analysis examines how 167 cities around the world advance their social, environmental, and economic agenda across eight urban domains.

To understand which levers of change work best, our economists correlated individual initiatives with returns on investment. This section details the levers of change that cities are applying across each domain and their impact on urban performance.

The eight urban domains

1. Economy, trade, and industry
Attracting business, generating growth and industrial development.

2. Government and education
Managing a city and its services and workers.

3. Living and health
Ensuring well-being and equity of citizens.

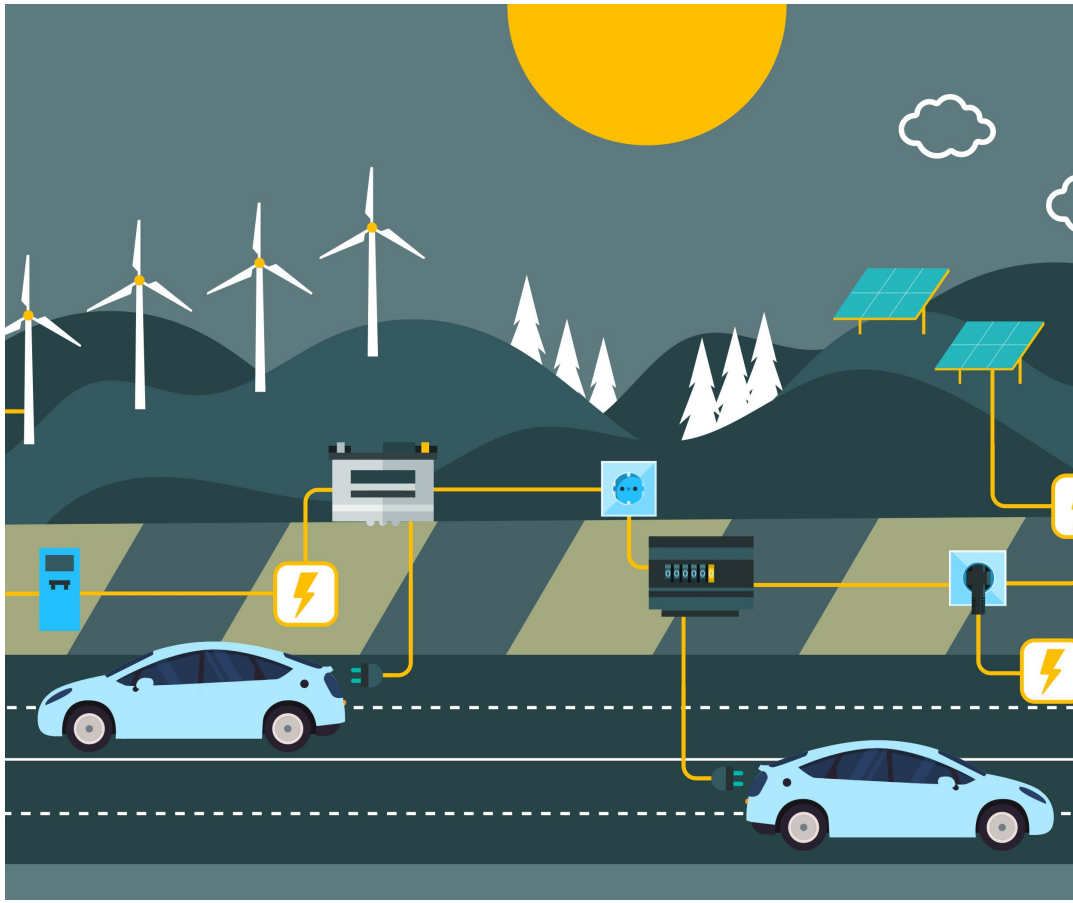
4. Public safety and security
Ensuring citizen safety and preventing crime.

5. Mobility and transportation
Enabling people and goods to move faster and safer.

6. Environment and sustainability
Improving sustainability and environmental quality.

7. Energy, water, and other utilities
Distributing energy, water, and other resources responsibly.

8. Digital infrastructure and networks
Connecting people, devices, and assets across a city.



Where cities are investing by domain

As cities progress across stages of sustainability development, their investment priorities shift.

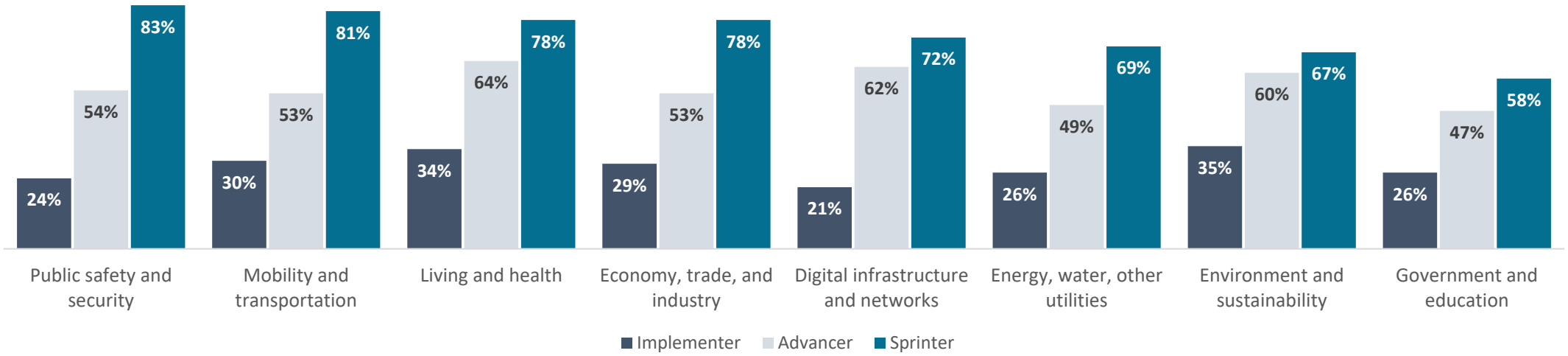
When starting out on their journey, cities prioritize investment in core areas that will ensure the health of their citizens and environment: living and health (34%) and environment and sustainability (35%).

As cities become SDG advancers, living and health (64%) and environmental sustainability (60%) remain priorities, but investments in digital infrastructure and networks jump in importance (62%).

Investment priorities shift further when cities become sprinters. All priorities rise, but particularly public safety, mobility, living and health, and economy and industry.

> "Smart innovation is the main driver to achieve the SDGs. Technology plays a crucial role in achieving sustainable cities and communities, as it is the key enabler for energy, water, air, traffic, buildings, and processes to work efficiently and in alignment with expected goals."
>
> **Jose Antonio Ondiviela, Western Europe Government, Smart Cities Solutions Director, Microsoft**

Investment priorities across urban domains in the next 3 years
(% citing high or very high priority)



Q14: Please rank your investment priorities (include investment from both operating and capital budgets) across the urban domains over the next three years.

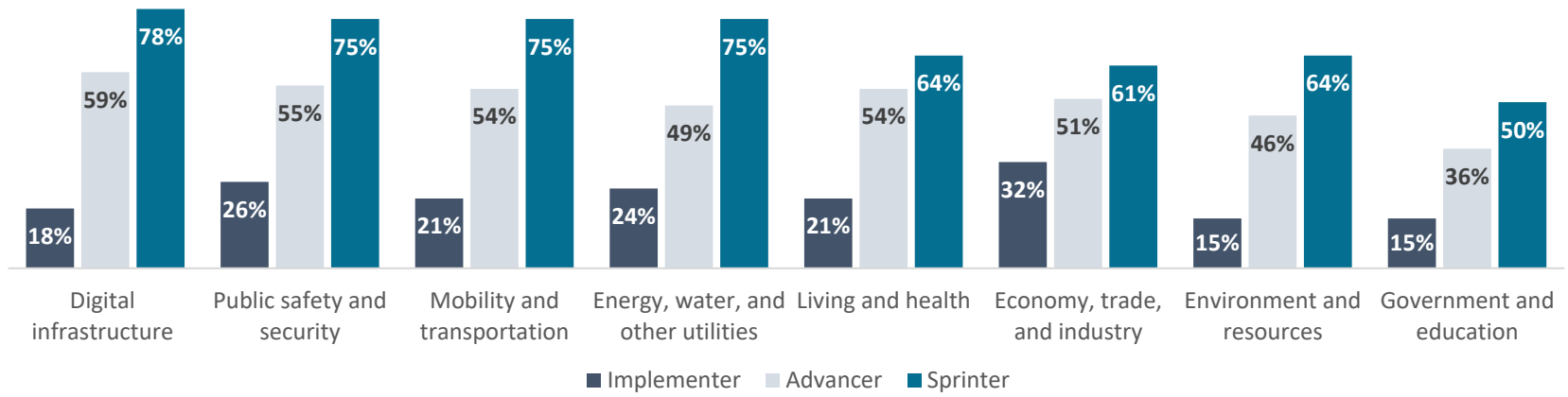
SDG sprinters harness digital technologies across all urban domains

Sustainable development and smart technology progress are mutually reinforcing. Cities are typically in early stages of digitizing urban domains when starting out on the SDGs. By the time they are sprinters, they are also digitally advanced across each of the urban domains.

By using smart technologies together with other levers of change, cities have been able to drive results across urban domains. One example is Moscow, an SDG sprinter, which has utilized blockchain to drive citizen engagement. The technology underpins Active Citizen, a platform created to allow citizens to vote on city issues, by storing data across multiple internal and independent databases, and guaranteeing that data will never be lost or changed upon submission to the system.

Sprinters have made the most progress in using technology in the areas of digital infrastructure (78%), public safety and security (75%), mobility and transportation (75%), and energy, water, and other utilities (75%). Sprinters have made less digital headway in the areas of economy and industry, and government and education. North American and European cities have advanced the most across the urban domains, and Africa the least.

Progress in using technology across the urban domains
(% maturing or leading)



"Investments should focus on emerging technologies that have direct impact on service delivery, such as cloud computing, AI, and IoT. The most ubiquitous solution will be cloud. The need to provide remote access to staff and residents is crucial for maintaining any sense of continuity."

John Tuohy, Director, Smart Cities Strategy, Oracle

Q18: Please tell us what progress your city has made in using technology solutions to achieve its goals within the following urban domains.

1. Economy, trade, and industry

Steps and solutions

Sprinters take an evidence-based approach to economic and industrial development. They also leverage their ecosystem better, from companies and universities to community partners.

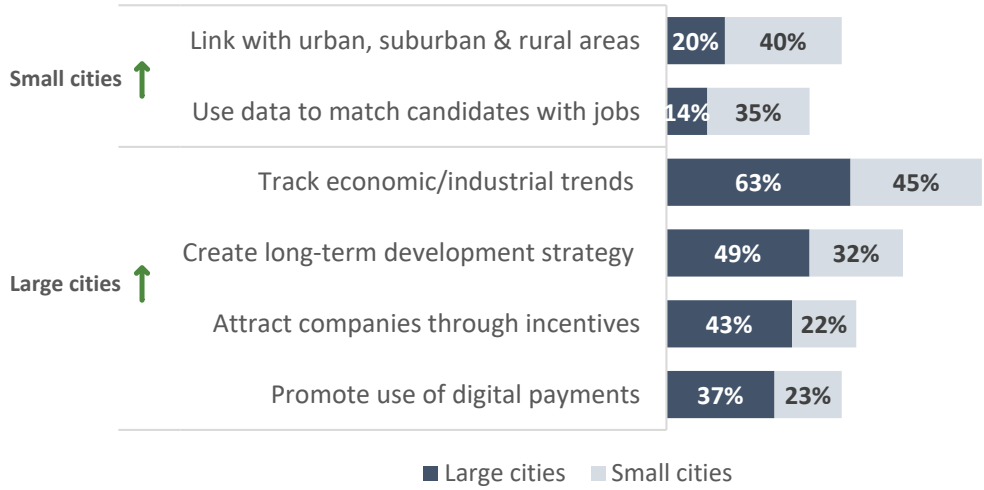
Most sprinters track and analyze economic and industrial trends to make decisions. They also work effectively with businesses, universities, and trade groups to build the expertise they need. Orlando is a prime example. Through its Greenworks Community Action Plan, it links with local universities, non-profits, and other community partners to advance the SDGs.

Large cities more often use economic and industry data to make decisions, while small cities use data more to match candidates with jobs. Large cities are more likely to have long-term development strategies that include attracting companies through incentives. Small cities are more apt to work with neighbors to promote development.

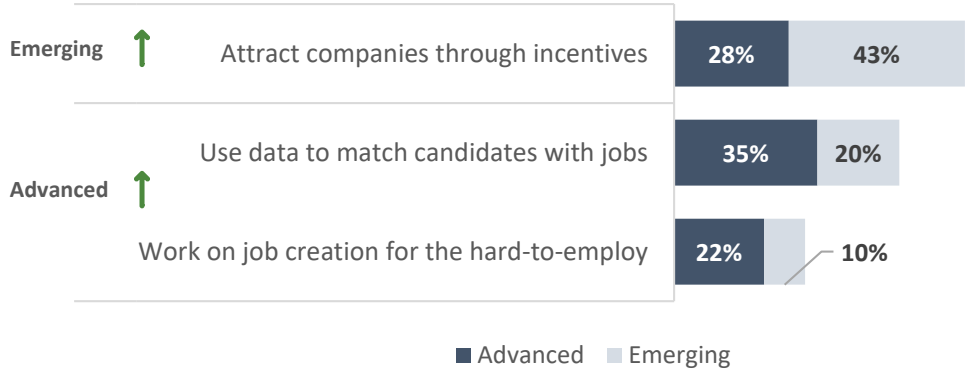
Most effective steps that SDG sprinters take

	Sprinters	Others
Track economic & industrial trends to make decisions	67%	47%
Work with business & academic community	58%	50%
Align higher education with local industry needs	53%	42%
Attract companies through incentives & work with trade groups	50%	32%
Attract/develop talent & skills	42%	41%

Where effectiveness diverges by city size



Where effectiveness diverges by market development



Q30: What are the most effective steps that your city is taking to improve economic, trade, and industry development?

2. Government and education

Steps and solutions

SDG sprinters draw on governance, partnerships, and data management to drive progress across the government and education domain.

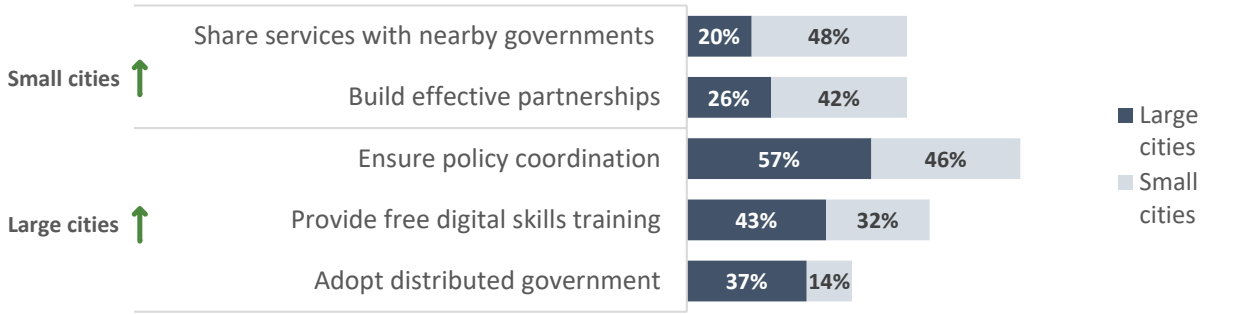
Sprinters shine at using metrics to track progress towards their goals. Most ensure consistency across their social, environmental, and economic policies and use participatory budgeting to get things done. Mindful of the need for digital inclusion, sprinters often provide citizens with free basic digital upskilling.

With more limited resources, small cities are ahead in working with nearby governments to share services and at building partnerships. Large cities lead in policy coordination, skills training, and distributed government.

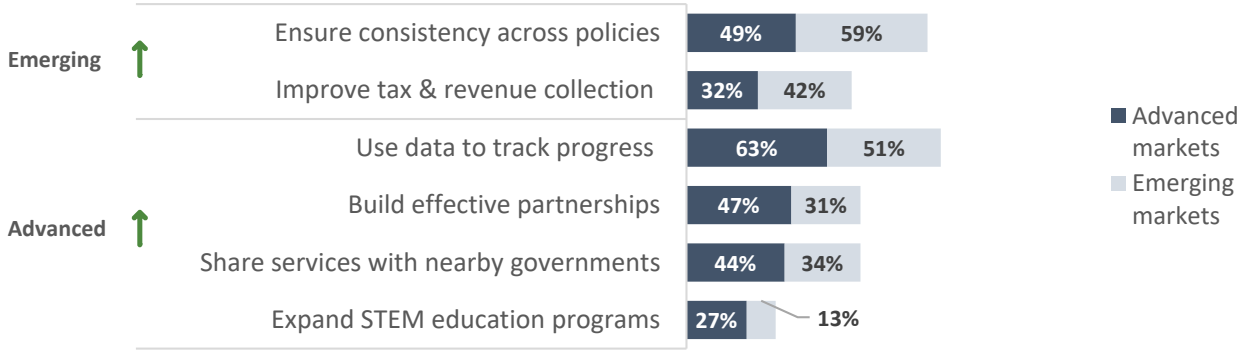
Most effective steps that SDG sprinters take

	Sprinters	Others
Use metrics to track progress against goals	72%	53%
Ensure consistency across policies	64%	52%
Use participatory budgeting	61%	60%
Provide free basic digital skills training	56%	36%
Build effective partnerships	47%	36%

Where effectiveness diverges by city size



Where effectiveness diverges by market development



"After the pandemic we will see the emergence of an adaptive governance style that focuses on data-driven decision-making, adopting emerging technology, and implementing innovative policies."

Miguel Eiras Antunes, Global Smart City, Smart Nation & Local Government Leader, Deloitte

Q31: What are the most effective steps that your city is taking to improve government and education?

2. Government and education

Investments and returns

Cities are investing in technology to transform most areas of government, from digital payment systems to automated processes and workflows.

Mindful of the limitations of cash, most cities are investing in digital payment systems to support e-government. More than eight out of 10 invest in digital payment systems for marketing and accepting payments. Fifty-six percent focus on digitizing the services and experiences for citizens and local businesses.

Partly in response to the pandemic, over three-quarters of cities are spending more on automating, streamlining, and speeding up government processes and workflows. Social distancing is also giving rise to online education, an investment area for over four out of 10 cities.

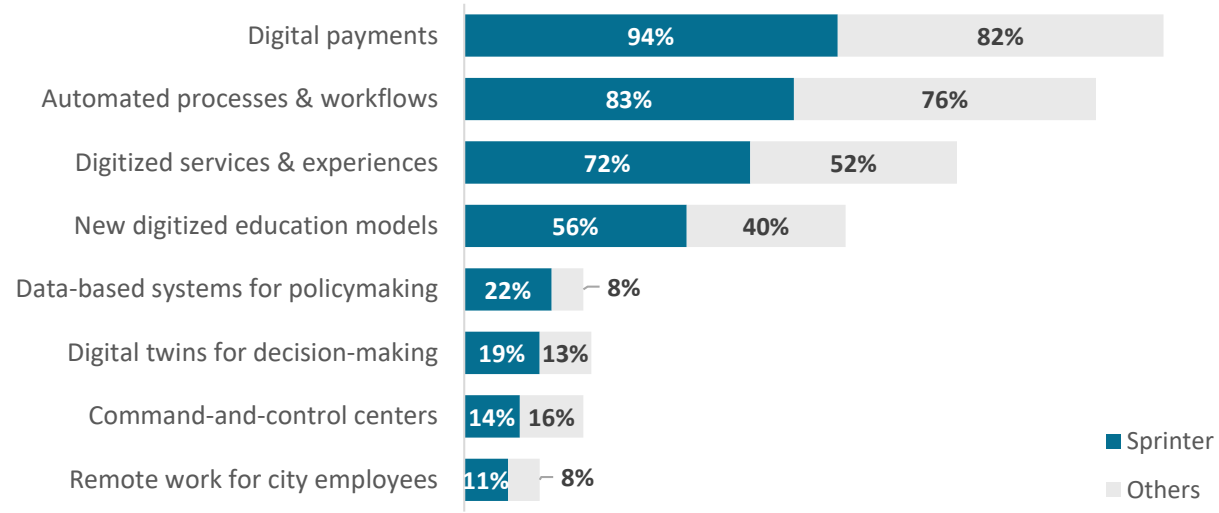
Not surprisingly, sprinters are better at using digital solutions to manage their cities. They invest more in technology to support citizens and employees. They also see better returns.

Most cities invested in		Largest return	
Digital payments	84%	Digital payments	6.37%
Automated processes & workflows	78%	Remote work for city employees	6.15%
Digitized services & experiences	56%	Automated processes & workflows	5.63%
New digitized education models	43%	Digitized services & experiences	5.29%

Where SDG sprinters outperform

Key indicators	Sprinters	Others
Number of tech investments	3.7	2.9
% of projects with positive ROI	97%	89%
Average ROI	5.57%	5.08%
Average years in place	2.5	2.4

Technology investments



Q32: In which of the following technology solutions are you making large investments, what ROI are you seeing, and how long has the project been in place?

3. Living and health

Steps and solutions

Sprinters excel at leveraging partnerships and data to cultivate citizen well-being, equality and inclusiveness, and other living and health goals. These objectives became everyday imperatives during the pandemic.

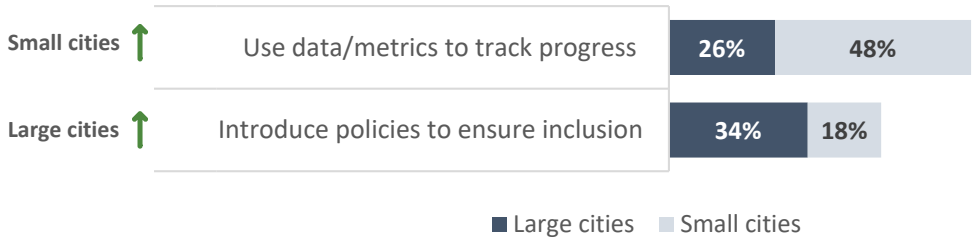
To improve citizen well-being, most cities partner with hospitals to increase healthcare access and collect data on epidemic diseases. But sprinters take these steps more often. They also do more to promote inclusiveness, from using data to track progress to introducing policies and programs to nurture equality. While sprinters are ahead in these areas, other cities are not far behind. In fact, other cities are slightly ahead in setting up social protection systems for all citizens.

The approach towards inclusion varies by population size: large cities tend to introduce policies and programs to drive inclusion, while small ones are more assiduous in tracking progress.

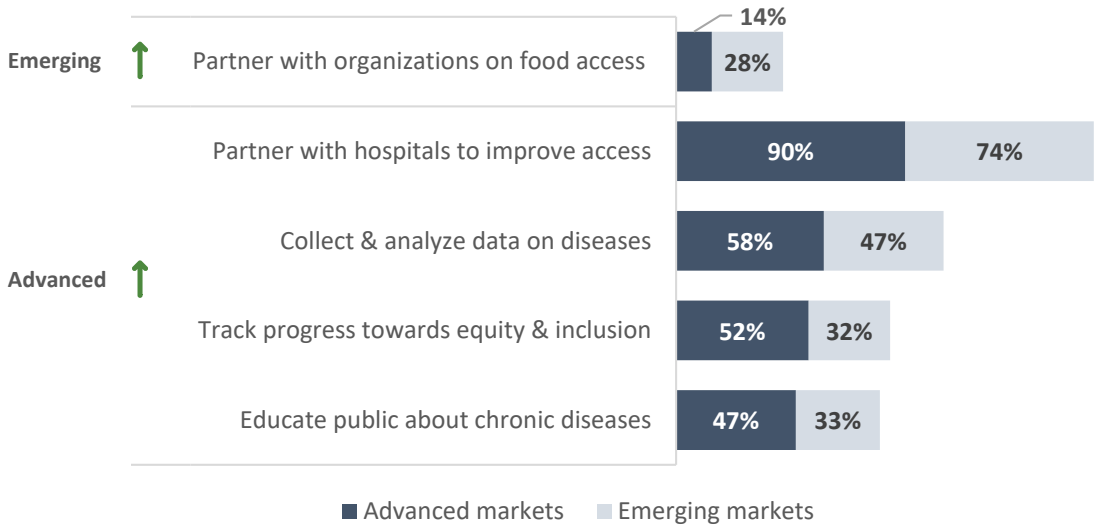
Most effective steps that SDG sprinters take

	Sprinters	Others
Partner with hospitals to improve healthcare access	86%	80%
Collect & analyze data on epidemic diseases	56%	51%
Use metrics to track progress towards inclusion goals	47%	40%
Provide social protection systems for all citizens	44%	47%
Introduce policies & programs to ensure equality	44%	21%

Where effectiveness diverges by city size



Where effectiveness diverges by market development



Q33: What are the most effective steps that your city is taking to improve living and health for your citizens?

3. Living and health

Investments and returns

Sprinters outdo other cities in investing in almost all technologies related to living and health, except track and trace.

The top digital investments for sprinters (and others) are in remote medicine and telehealth services and online government benefits portals, solutions that also yield the highest returns. These investments served cities well as they worked to ensure that citizens and employees had access to needed healthcare and financial assistance during the pandemic.

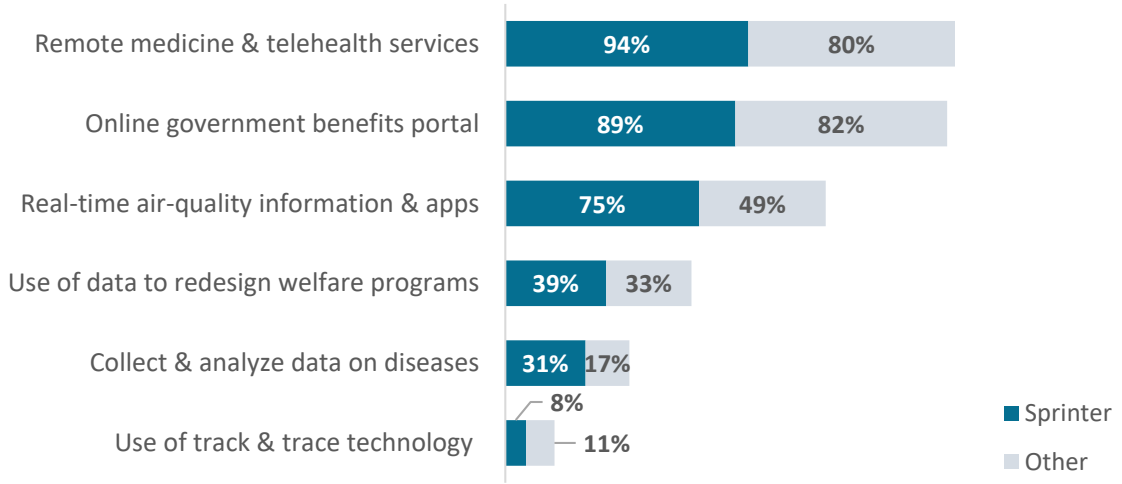
While all cities have focused on those two technologies, sprinters are far ahead of others in investing in real-time air quality data and apps. They are also ahead in other data areas, including collecting and analyzing data on epidemic diseases and using data to redesign public welfare programs.

Most cities invested in		Largest return	
Remote medicine & telehealth services	83%	Remote medicine & telehealth services	6.16%
Online government benefits portal	83%	Online government benefits portal	5.90%
Real-time air-quality information	54%	Use of track & trace technology to ensure health & well-being	5.47%
Use of data to redesign public welfare programs	34%	Real-time air-quality data & apps for those with chronic diseases	5.31%

Where SDG sprinters outperform

Key indicators	Sprinters	Others
Number of tech investments	3.4	2.7
% of projects with positive ROI	91%	88%
Average ROI	5.62%	5.17%
Average years in place	2.5	2.4

Technology investments



Q34: In which of the following technology solutions are you making large investments, what ROI are you seeing, and how long has the project been in place?

4. Public safety

Steps and solutions

Keeping citizens safe takes teamwork. Sprinters combine the use of partnership, data, and good governance practices to improve the public safety and security of their city.

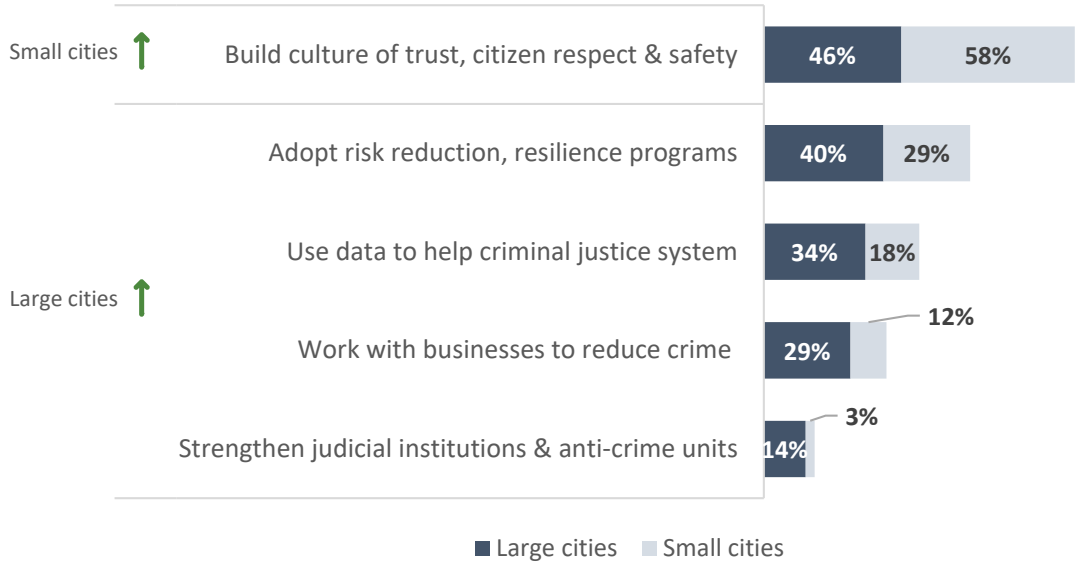
Sprinters lead in working with neighborhood groups and in sharing data with law enforcement agencies. They also are better at adopting disaster risk reduction and resilience programs.

Large cities lead in several areas: disaster risk reduction, use of data to support the criminal justice system, collaboration with business, and building of strong judicial institutions and anti-crime units. Small cities are ahead in building a culture of trust, something more difficult to accomplish in large, more complex cities with bigger populations.

Most effective steps that SDG sprinters take

	Sprinters	Others
Work with neighborhood groups to keep citizens safe	83%	76%
Share data on crime with law enforcement	58%	39%
Build a culture of trust, citizen respect & safety	42%	53%
Adopt disaster risk reduction, preparedness & resilience	39%	36%
Promote citizen safety through urban planning & design	36%	45%

Where effectiveness diverges by city size



Where effectiveness diverges by market development

Share data on crime with law enforcement and intelligence agencies

52% Advanced

35% Emerging

Q35: What are the most effective steps that your city is taking to improve public safety and security?

4. Public safety

Investments and returns

Sprinters lead in investing in all public safety technologies. They are furthest ahead in disaster early warning systems, computer-aided dispatch, drones, and in-car and body cameras for police.

Despite citizen concerns around privacy, facial recognition and biometrics is the top area of investment for sprinters and others alike, with more than eight out of 10 cities investing in those technologies. This security method generates the largest ROI for cities. And despite their trepidation about this technology, 43% of citizens (53% in advanced economies) favor facial recognition if used to fight crime.

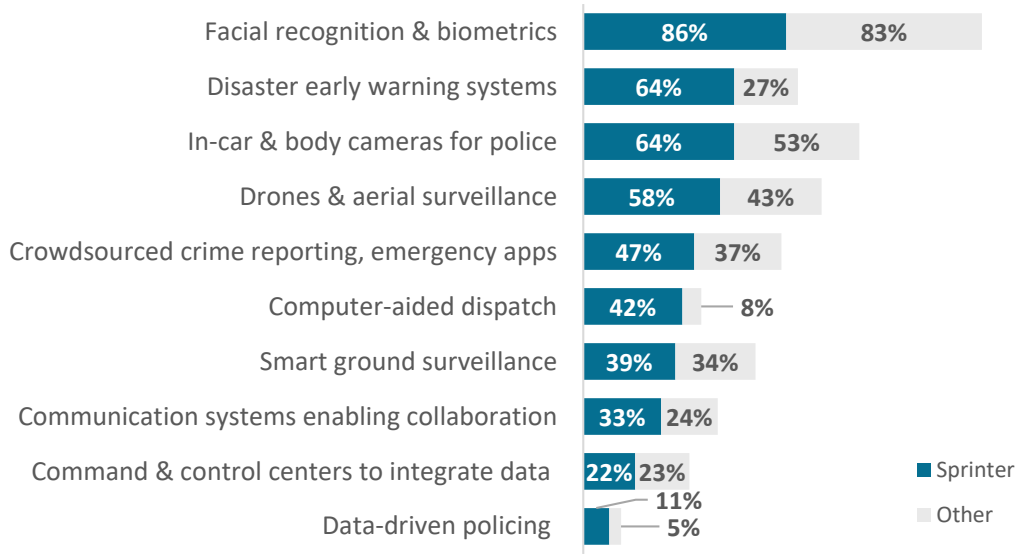
Other technologies generating big returns for cities are communication systems that enable information sharing, police in-car and body cameras, and crowdsourced crime reporting apps.

Most cities invested in		Largest return	
Facial recognition & biometrics	84%	Facial recognition & biometrics	6.17%
In-car & body cameras for police	55%	Communication systems enabling agencies to share information	6.04%
Drones & aerial surveillance	46%	In-car & body cameras for police	5.61%
Crowdsourced crime reporting & emergency apps	39%	Crowdsourced crime reporting & emergency apps	5.58%

Where SDG sprinters outperform

Key indicators	Sprinters	Others
No. of tech investments	4.7	3.4
% of projects with positive ROI	91%	89%
Average ROI	5.34%	5.25%
Average years in place	2.7	2.6

Technology investments



Q36: In which of the following technology solutions are you making large investments, what ROI are you seeing, and how long has the project been in place?

5. Mobility and transportation

Steps and solutions

Sprinters utilize each of the levers of change—partnerships, innovative funding, technology, data, and governance and policy—to help people and goods move faster, more safely and efficiently, and without leaving a carbon footprint.

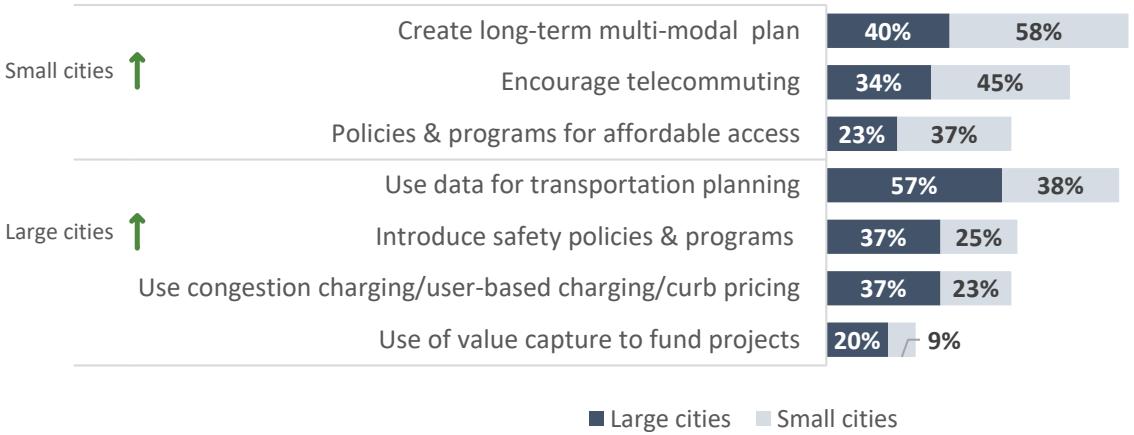
Sprinters are adept at using data to develop their mobility and transportation plans. They are more likely to set transportation safety policies and use congestion charging and other innovative pricing techniques. However, sprinters sometimes overlook working with neighboring jurisdictions and creating a long-term multi-modal vision.

Small cities lead in creating long-term mobility plans, encouraging telecommuting, and providing affordable transportation access. Large cities are better at using data, introducing safety policies and programs, and using congestion pricing and similar techniques.

Most effective steps that SDG sprinters take

	Sprinters	Others
Use data for transportation planning	69%	47%
Work with neighboring cities for trans-border transportation	64%	68%
Create long-term multi-modal urban mobility vision	44%	57%
Introduce policies & programs to improve safety for all	42%	27%
Use congestion charging/user-based charging/curb pricing	42%	24%

Where effectiveness diverges by city size



How effectiveness compares by market development

	Advanced	Emerging
Work with neighboring cities to develop trans-border transportation infrastructure	72%	63%
Create a long-term multi-modal urban mobility vision & plan	59%	50%
Use data & analytics for transportation planning	56%	48%
Work with businesses & governmental departments to encourage telecommuting	39%	40%
Introduce policies & programs to improve safety for all	34%	26%

Q37: What are the most effective steps that your city is taking to improve mobility and transportation?

5. Mobility and transportation

Investments and returns

Sprinters lead in investing in public safety technologies, particularly solutions that facilitate use of public transportation. These include digital/open-loop payments, mobility-as-a-service apps, and demand-based micro transit.

Our survey shows that 54% of cities around the world are rethinking their mobility and transportation approaches because of COVID-19 and the vulnerabilities associated with climate change. This is reflected in the high number of technology investments and the strong focus on public transportation data and access.

Yet one technology that is struggling to catch on in cities, regardless of their maturity, is data and analytics for predictive maintenance of transportation infrastructure. This is a missed opportunity since predictive maintenance can greatly reduce downtime.

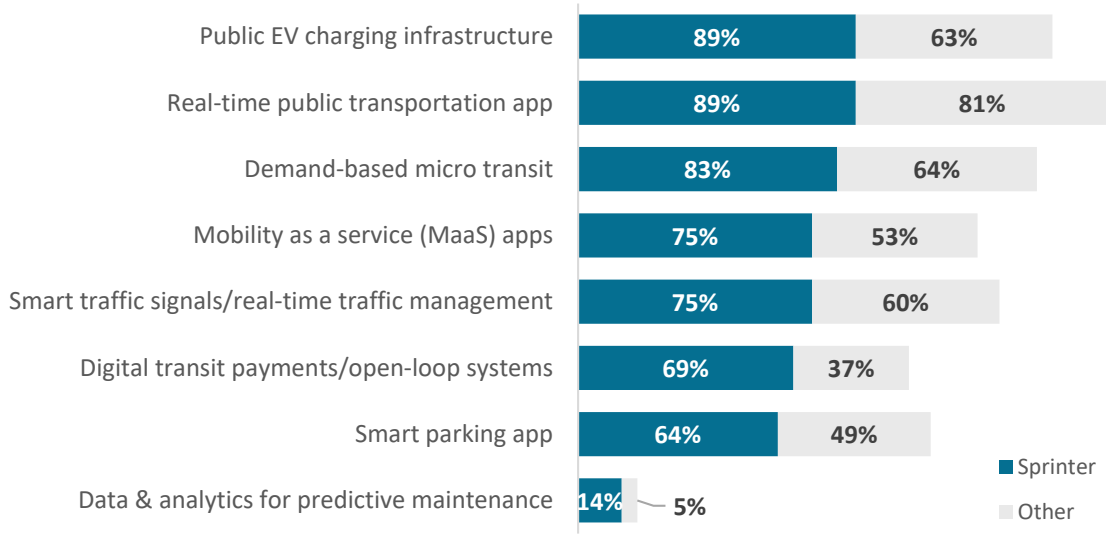
The technologies generating the greatest returns are real-time public transportation apps, public EV charging, MaaS apps, and smart parking apps.

Most cities invested in		Largest return	
Real-time public transportation app/information	83%	Real-time public transportation app/information	6.59%
Demand-based micro transit, such as ride-sharing & shuttle vans	68%	Public electric vehicle charging infrastructure	5.56%
Public electric vehicle charging infrastructure	68%	Mobility as a service (MaaS) apps	5.48%
Smart traffic signals/real-time traffic management	63%	Smart parking app	5.32%

Where SDG sprinters outperform

Key indicators	Sprinters	Others
Number of tech investments	5.6	4.1
% of projects with positive ROI	93%	89%
Average ROI	5.69%	5.18%
Average years in place	2.6	2.5

Technology investments



Q38: In which of the following technology solutions are you making large investments, what ROI are you seeing, and how long has the project been in place?

6. Environment and sustainability

Steps and solutions

For sprinter cities, sustainability metrics form the foundation of the local planning process, helping to ensure that the environment and the impact of climate change are top of mind.

Sprinters work with others to address environmental woes. They collaborate with partners to reduce food and other waste and with neighboring cities to ensure the sustainable use of ecosystems.

Small cities are ahead in incorporating metrics into their planning processes and in working with companies to achieve their sustainability goals. Large cities take it up a notch: they lead in promoting the circular economy and using gamification to boost recycling.

Cities in emerging markets—where large informal sectors already engage in circular practices in areas like electronic waste—are ahead in promoting the circular economy. Advanced cities lead in reducing food waste and adopting zero waste programs and digital tracking of waste disposal.

Most effective steps that SDG sprinters take

	Sprinters	Others
Incorporate sustainability metrics into local planning process	89%	66%
Work with partners to reduce food waste	64%	36%
Work with neighboring cities for sustainable use of ecosystems	61%	72%
Adopt zero waste programs	47%	23%
Use digital tracking & payment for waste disposal	39%	15%

Where effectiveness diverges by city size

Where effectiveness diverges by market development

Q40: What are the most effective steps that your city is taking to improve the environment and sustainability?

6. Environment and sustainability

Investments and returns

Water and air quality monitoring systems are table stakes for sprinters as part of their arsenal of environment-related investments—and other cities are quickly catching up. Such monitoring systems generate the highest returns.

Real-time monitoring of air and water quality is common across most cities. But other digital techniques—such as data analytics to optimize waste collection routes and provide flood warnings—are often overlooked. That is a missed opportunity since the ROI on using data to optimize collection routes is only modestly lower than water and air quality monitoring. The use of analytics to predict floods, while a much lower priority at present, likely will grow as climate change exacerbates flooding risks in many cities.

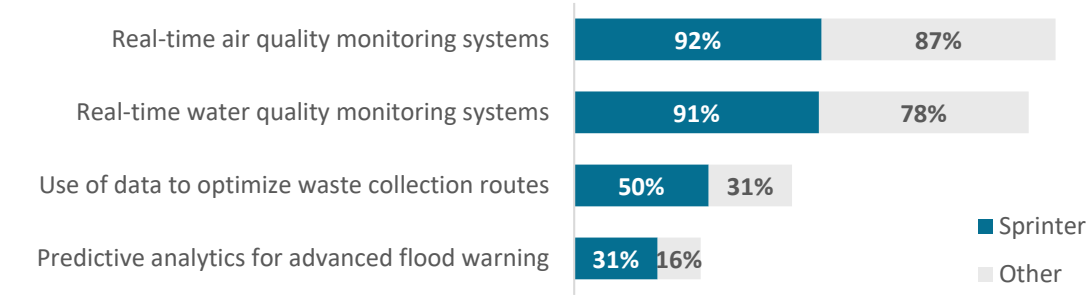
The most forward-looking cities are increasingly incorporating climate risk factors into strategic, holistic planning so to minimize costs and maximize benefits.

Most cities invested in		Largest return	
Real-time air quality monitoring systems	88%	Real-time air quality monitoring systems	5.66%
Real-time water quality monitoring systems	81%	Real-time water quality monitoring systems	5.28%
Use of data to optimize waste collection routes	35%	Use of data to optimize waste collection routes	4.91%
Predictive analytics for advanced flood warning	19%	Predictive analytics for advanced flood warning	3.34%

Where SDG sprinters outperform

Key indicators	Sprinters	Others
No. of tech investments	2.6	2.0
% of projects with positive ROI	93%	87%
Average ROI	5.41%	5.00%
Average years in place	2.7	2.5

Technology investments



"In response to extreme weather events, rising population, and inadequate drainage, cities around the world are at risk of flooding. Floods have an impact on human safety, the economy, and more. In response to these threats, cities are striving to improve their flood resilience with data-driven planning, development, and operations. Some cities are accomplishing this using digital twins to improve the resilience of current infrastructure."

Ton de Vries, Senior Director, Business Development, Bentley Systems

Q41: In which of the following technology solutions are you making large investments, what ROI are you seeing, and how long has the project been in place?

7. Energy, water, and other utilities

Steps and solutions

Cities focus on leveraging the ecosystem to achieve their goals in the energy, water, and other utilities domain, while promoting cleanliness and efficiency.

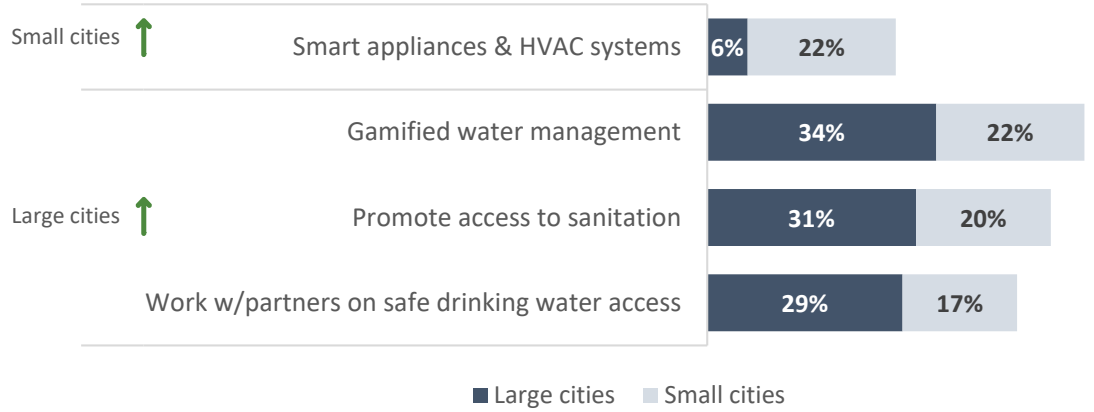
Sprinters are most adept at partnering with technology vendors to enhance services, encouraging use of renewable energy, and promoting efficient water usage. They lead in using innovative business models, such as dynamic electricity pricing and gamified water use management.

Small cities are more effective in promoting the use of smart appliances and HVAC systems. Large ones are ahead in gamified water management, working with partners on safe drinking water, and promoting access to sanitation. Emerging market cities are working harder to provide safe and affordable water—a particularly serious problem in many poorer countries.

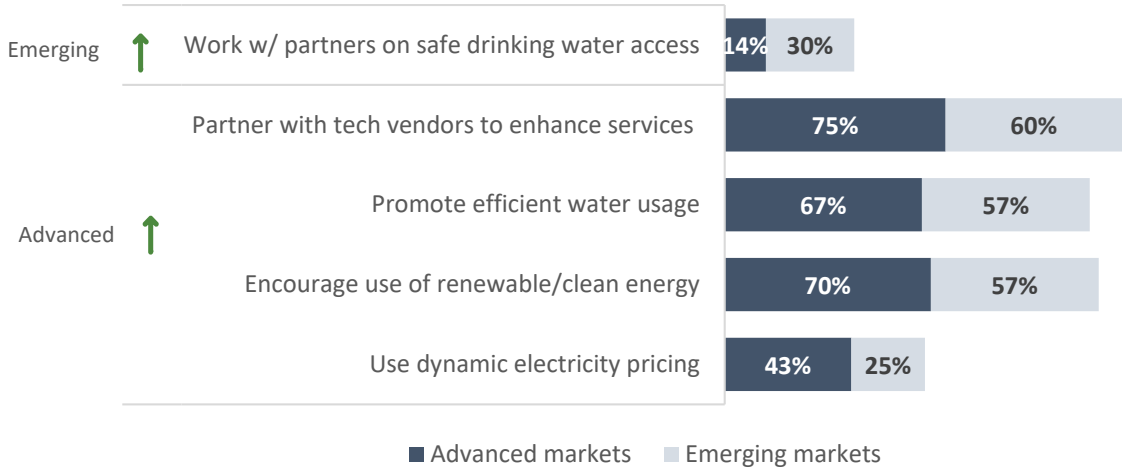
Most effective steps that SDG sprinters take

	Sprinters	Others
Partner w/ technology vendors to enhance services	78%	64%
Encourage use of renewable/clean energy	67%	62%
Promote efficient water usage	64%	61%
Use dynamic electricity pricing	42%	39%
Adopt gamified water use management	39%	24%
Work w/ partners to achieve access to energy services	39%	23%

Where effectiveness diverges by city size



Where effectiveness diverges by market development



Q43: What are the most effective steps that your city is taking to improve energy, water, and other utilities?

7. Energy, water, and other utilities

Investments and returns

Sprinters are more advanced in adopting technologies for energy and other utilities. Their top investments help to empower citizens to make better resource usage decisions.

These technologies include apps to allow citizens to track and manage their resource usage and smart meters, for both water and electricity. All of these generate firm returns.

One technology where cities are trailing badly is data analytics to help make better predictive maintenance decisions. Only 15% of cities use data to make such decisions about their water infrastructure and 8% use it for electricity infrastructure.

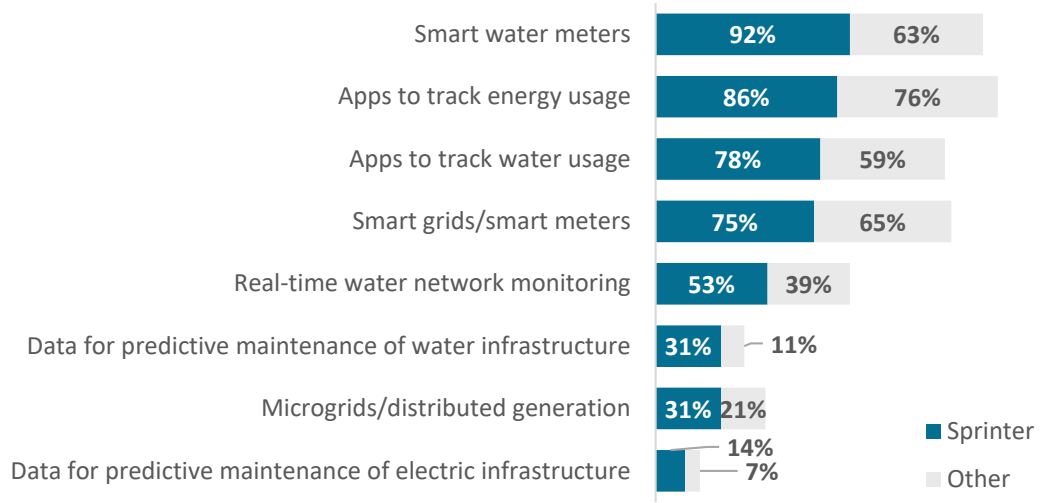
Porto, Portugal is an example of a city using smart technology to improve its urban water cycle. It commissioned development of a smart water management platform called H2Porto. This digital twin has helped to improve the accuracy of data produced from sensor readings to nearly 99%. After deploying the technology, the city's water service interruptions fell by 22.9%; sewer collapses decreased by 54%; and repairs for pipe burst and sewer and service connections improved by 8.3% and 45.5%, respectively. The integration of real-time data and the ability to access information in the field helped to improve operations by 23%.

Most cities invested in		Largest return	
Apps to track & manage energy usage	78%	Smart water meters	6.02%
Smart water meters	69%	Smart grids/smart meters	5.88%
Smart grids/smart meters	67%	Apps to track & manage energy usage	5.32%
Apps to track & manage water usage	63%	Apps to track & manage water usage	5.23%

Where SDG sprinters outperform

Key indicators	Sprinters	Others
No. of tech investments	4.6	3.4
% of projects with positive ROI	89%	87%
Average ROI	5.15%	5.02%
Average years in place	2.8	2.5

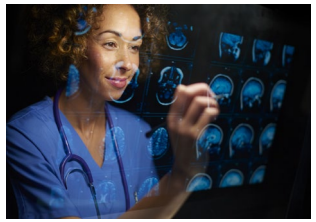
Technology investments



Q44: In which of the following technology solutions are you making large investments, what ROI are you seeing, and how long has the project been in place?

8. Digital infrastructure and networks

Steps and solutions



Sprinters strive to close the digital divide—a priority for cities and citizens entering a post-pandemic, digital-first world. They work with telecom providers to provide reliable and affordable access,

Sprinters are better at using data and analytics to understand where the divide exists, providing free Wi-Fi, working with partners to provide free devices, and leveraging PPPs to foster digital equity. They also lead other cities in monetizing their infrastructure, with almost 40% leasing city-owned infrastructure to telecom providers.

Large cities are more apt than small ones to partner with telecom providers to provide smart services. Cities in advanced markets more often provide free Wi-Fi, while emerging market cities focus more on partnering to secure free or low-cost devices. Advanced cities use data analytics to understand the digital divide, while emerging cities use PPPs to close it.

Most effective steps that SDG sprinters take

	Sprinters	Others
Use data and analytics to understand digital divide	64%	45%
Provide free Wi-Fi or access to computer facilities	64%	37%
Partner with telecom providers to provide smart city services	47%	47%
Lease city-owned infrastructure to telecom companies	39%	15%
Work with partners to provide free or low-cost devices	36%	32%
Leverage public-private partnerships for digital equity issues	36%	27%

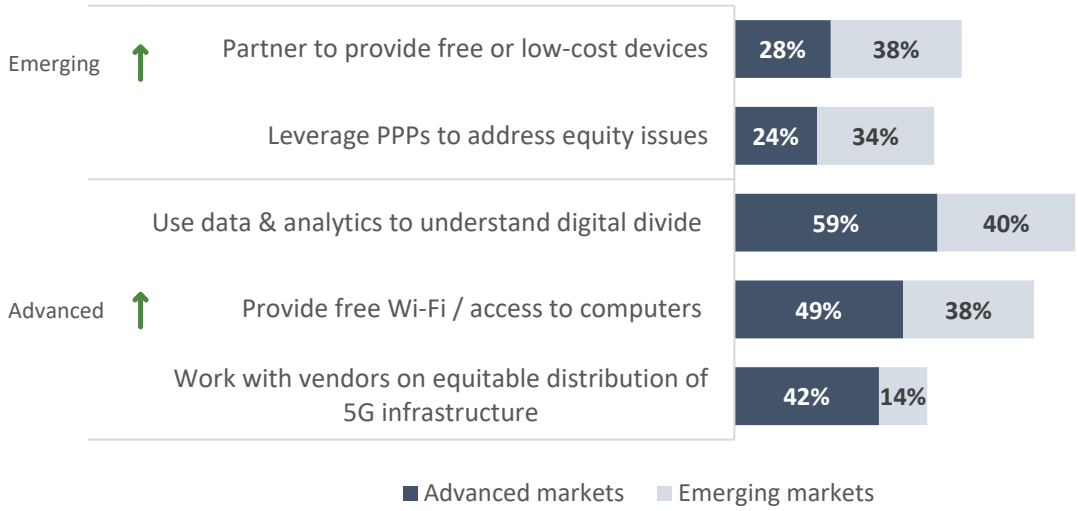
Where effectiveness diverges by city size

Partner with telecom providers to offer smart city services

54% Large cities

42% Small cities

Where effectiveness diverges by market development



Q46: *W*hat are the most effective steps that your city is taking to improve digital infrastructure and telecom networks?

8. Digital infrastructure and networks

Investments and returns

For sprinters, public Wi-Fi, IoT, and cloud have become commonplace, with over 90% of them investing in those technologies. Yet other cities are quickly catching up.

Smart streetlights and mesh networks are two areas that generate strong ROI but are not getting as much investment as they deserve—55% of cities overall have invested in smart streetlights and less than 20% have installed a mesh network.

Public Wi-Fi is the top digital investment for cities, while investments in other low-cost internet solutions are trailing. That includes municipal broadband and public fiber networks. As cities work more diligently to bridge the digital divide, investments in these technologies are sure to increase.

Most cities invested in		Largest return	
Public Wi-Fi network	89%	Public Wi-Fi network	6.55%
Cloud technology	84%	Cloud technology	6.52%
IoT	80%	Smart stations	6.38%
Smart stations	68%	Smart streetlights	6.17%
Smart streetlights	55%	Mesh networks	6.06%

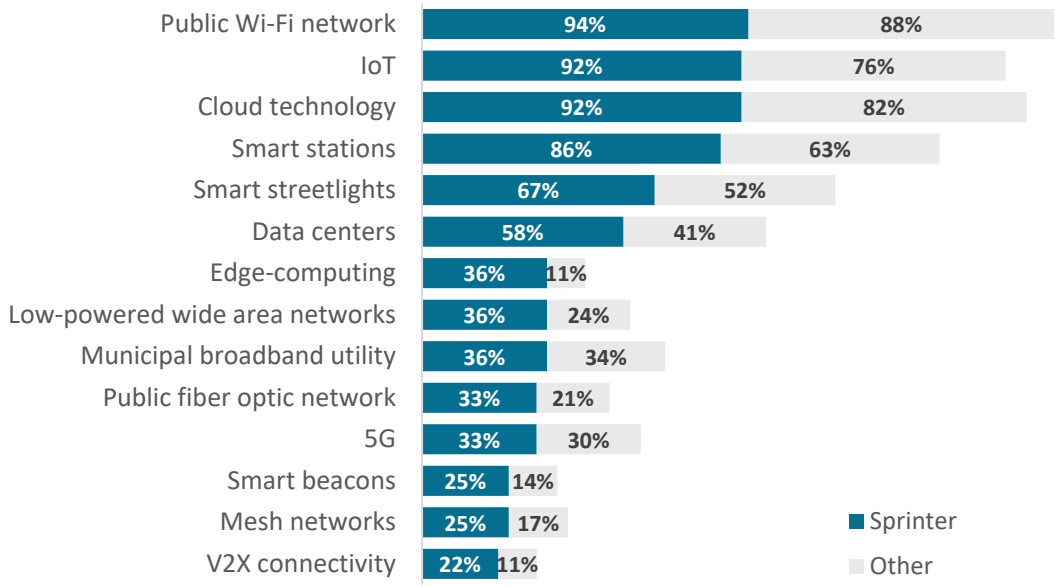
"Cities will transition to digital not just because it is faster, but also because it uses less resources, is environmentally friendly, and is safer."

Raul Garcia-Rodriguez, Advisor, Real Estate Market Advisory Group, UNECE

Where SDG sprinters outperform

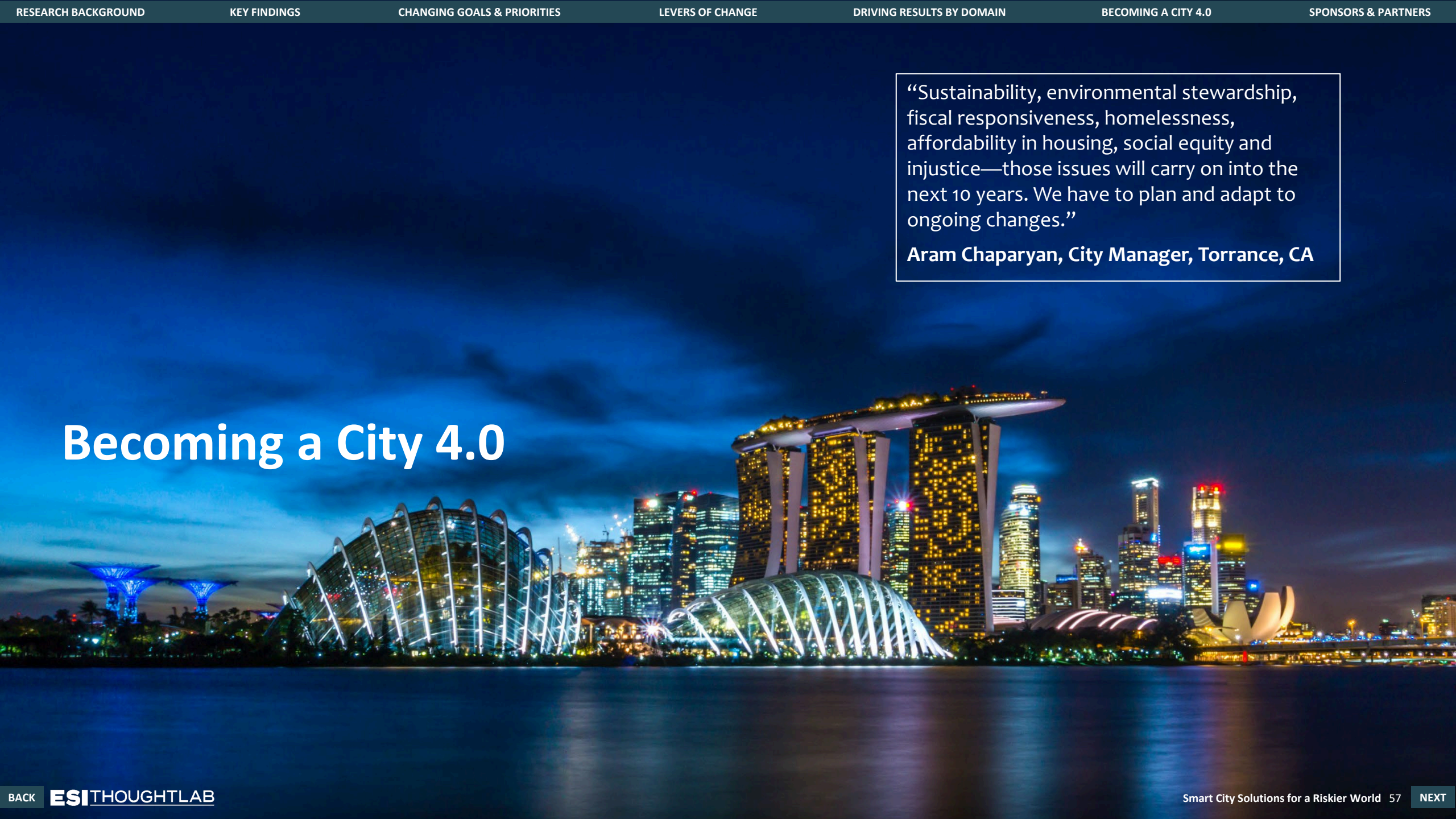
Key indicators	Sprinters	Others
Number of tech investments	7.4	5.6
% of projects with positive ROI	90%	91%
Average ROI	5.50%	5.79%
Average years in place	2.6	2.8

Technology investments



Q47: In which of the following technology solutions are you making large investments, what ROI are you seeing, and how long has the project been in place?

Becoming a City 4.0



> "Sustainability, environmental stewardship, fiscal responsiveness, homelessness, affordability in housing, social equity and injustice—those issues will carry on into the next 10 years. We have to plan and adapt to ongoing changes."
>
> **Aram Chaparyan, City Manager, Torrance, CA**

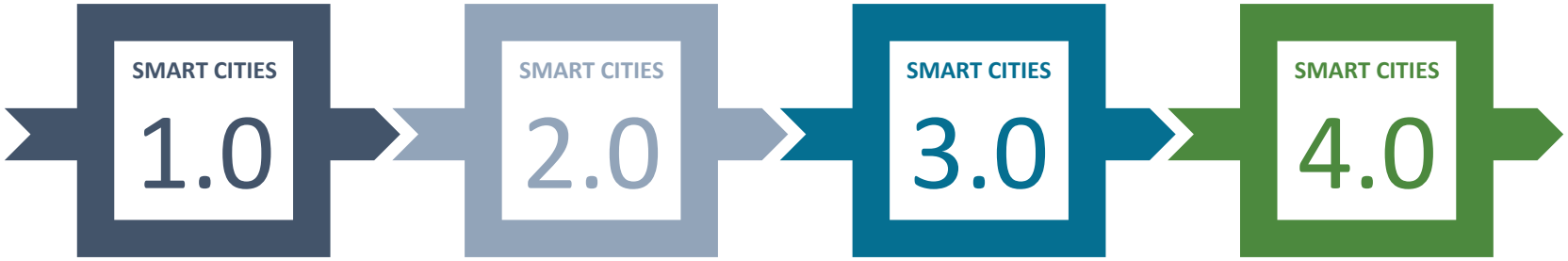
The evolution of smart cities to Cities 4.0

Urban centers will need to become Smart Cities 4.0 to prosper and grow after the pandemic.

Even before the health emergency, cities were evolving into smarter cities, learning from mistakes made early in their digital journey.

The pandemic has exposed the need for cities to go beyond what some have categorized as Cities 3.0 to become Cities 4.0 in order to achieve their social, environmental, and economic goals. With the pandemic permanently changing citizen needs and behaviors, and businesses gearing up for the Fourth Industrial Revolution, tomorrow's cities will need to be hyperconnected, fully sustainable, citizen-centric, and partnership focused, They will also need to be skilled in the new way of doing business.

Smart city stages of development



Smart Cities 1.0 pilot solutions offered by tech suppliers. But they often see technology as an end, rather than a means for meeting citizen needs. Cities 1.0 are often ill-equipped to capitalize on these investments and misread impact on citizens.

Smart Cities 2.0 focus on digital solutions to achieve their social agenda. They recognize that technology can improve most services to residents. However, they often lack the full support of all citizens, many of whom may be left out of decision-making.

Smart Cities 3.0 are attuned to sensitive social and digital issues. They include citizens in decision-making and strive to act on their behalf. They also understand the value of technology to transform and interconnect their urban ecosystems.

Smart Cities 4.0 are hyperconnected cities that use technology, data, and citizen engagement to achieve the SDGs. They are in step with new ways of working under Industry 4.0 and excel at using partners to drive change and provide innovative funding methods.

Cities 4.0 include Aarhus, Athens, Baltimore, Barcelona, Berlin, Birmingham, Boston, Copenhagen, Helsinki, London, Los Angeles, Madrid, Moscow, New York, Orlando, Paris, Philadelphia, Singapore, Tallin, and Vienna.

Source: https://www.fastcompany.com/3047795/the-3-generations-of-smart-cities

The four steps to becoming a City 4.0

1

Leverage latest technology

Cities 4.0 have made sizable investments in foundational technologies, such as cloud, mobile, IoT, and RPA, as well as more specialized solutions, such as biometrics, blockchain, AI, and telematics. They use smart technology and applications to advance the SDGs.

2

Make data a strategic asset

Cities 4.0 draw on diverse types of data. They are particularly ahead in actively using IoT, citizen usage, biometric, geospatial, peer-based, business, and real-time data.

3

Take advantage of the ecosystem

Cities 4.0 work more with partners outside of local government. This includes academic institutions, neighborhood communities, industry associations, city networks, companies, and financial institutions.

4

Engage their citizens

More than half of Cities 4.0 analyze the needs and expectations of citizens and proactively get their feedback. And more than six out of ten work closely with employees to understand their needs.

Cities 4.0 use smart technology smartly

Focus on cybersecurity

95% of Cities 4.0 ensure that cybersecurity is considered early in the process, compared with 51% of other cities.

Lead the digital effort

75% of Cities 4.0 have a senior executive and a written framework guiding the use of technology vs. only 40% of other cities.

Create an innovation hub

65% of Cities 4.0 have an innovation hub to promote the adoption of advanced technologies vs. 41% of other cities.

Prioritize interoperability

60% of Cities 4.0 prioritize interoperability and take steps to break down barriers between departments against 47% of other cities.

Build digital equity

50% of Cities 4.0 have improved digital equity through their investments, compared with 27% of other cities.

Allocate digital funding

50% of Cities 4.0 allocate funding for smart technologies when planning physical infrastructure projects vs. only 30% of other cities.

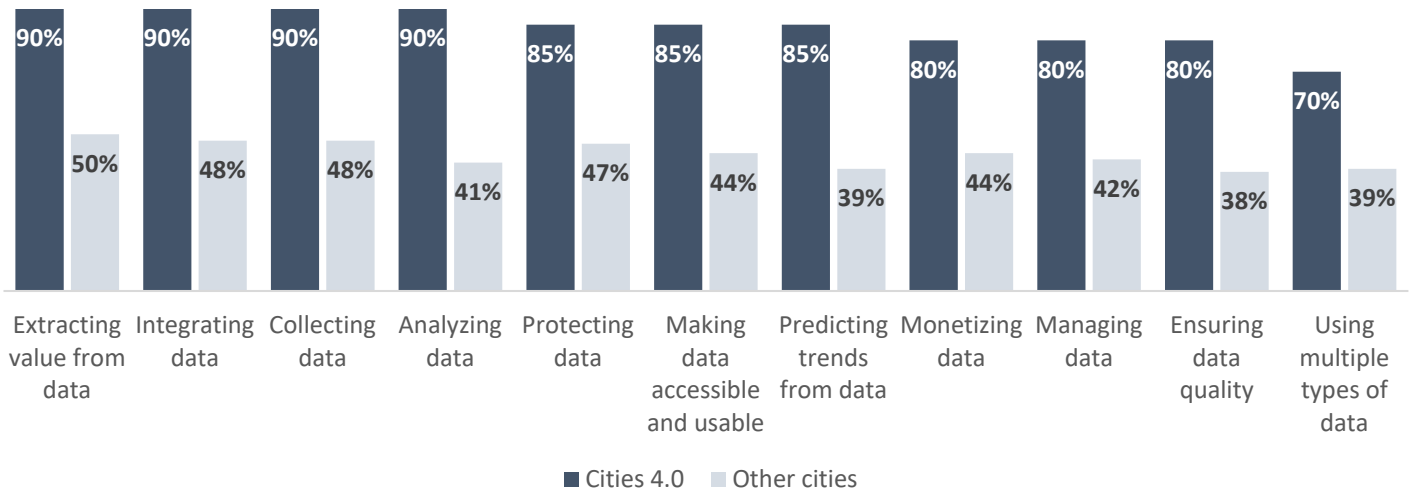
Q19: Which of the following statements do you agree with relating to your city's approach to digital innovation?

Cities 4.0 excel at data management

Cities 4.0 are well ahead of other cities in all aspects of data management. They are masters at collecting, integrating, protecting, and making data accessible to citizens. They also are superior at extracting value from data and do a better job of monetizing and analyzing data, including predictive analysis.

Cities 4.0 take concrete steps to harness data effectively. Most have policies, resources, and budgets in place to manage and analyze data at a high level of excellence. They tend to be more open in their use of data and integrate it across city departments.

Data maturity
(% citing maturing or leading)



Data management steps taken by Cities 4.0

1. **70%** have a written data policy to ensure the proper management of data.
2. **65%** have necessary data analytics, strategic thinking, and problem-solving skills.
3. **65%** have a system that integrates data across city departments.
4. **55%** ensure that there is the appropriate budget for data management.
5. **50%** have an open approach to encourage data usage and development.

Q21 and 21a: Which of the following statements on data management do you agree with? Which of the following areas are covered in your data management policy? Q23: Please tell as your city's maturity stage (maturing or leading) in the following areas.

Cities 4.0 unlock greater value from their ecosystems

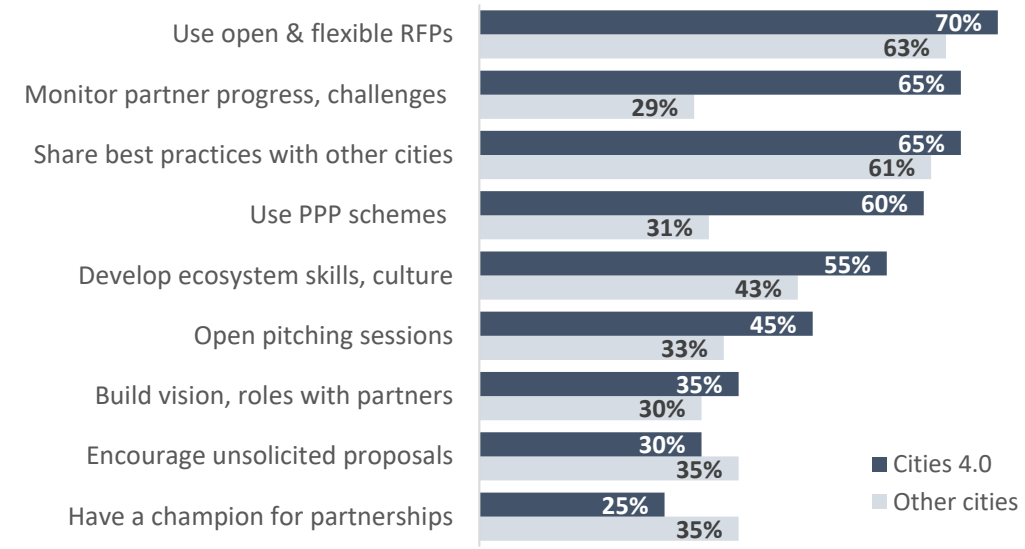
Cities 4.0 are more proactive, capable, and innovative in harnessing ecosystems. They also are better at PPPs and are more autonomous.

Using open and flexible RFPs and sharing best practices with other cities have become standard fare for most cities, regardless of their maturity. But Cities 4.0 stand out in five ways:

1. **Proactively manage partnerships.** Cities 4.0 monitor progress and challenges during their partnerships so that they can make continual improvements.
2. **Develop partnership skills across their city.** Rather than appointing one person to manage partnerships, Cities 4.0 cities develop the skills, capabilities, and culture to promote partnerships across domains.
3. **Prioritize public-private partnerships.** Most Cities 4.0 use PPP schemes, compared with just a third of other cities. The availability of favorable vendor financing or models is a key selection criterion.
4. **Open to new ideas.** Cities 4.0 invite ecosystem partners to help solve their problems by holding open pitching sessions, where third parties can offer innovative ideas.
5. **Autonomous in pursuing goals.** Cities 4.0 enjoy greater personnel, fiscal, functional, and regulatory independence than other cities from national, state, and provincial control.

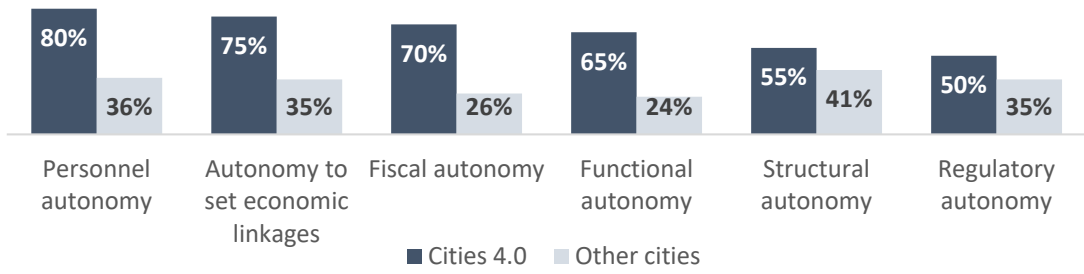
> "We don't put technology at the top of our agenda. We focus more on public-private partnerships. To pursue the right policies, to speed up recovery, we need the private sector. Not only for resources, but also for the model or design of policies. Sometimes when the private sector helps design the policies, they bring the technology as well."
>
> **Miquel Rodriguez Planas, 2030 Agenda Commissioner, Barcelona City Council**

How Cities 4.0 practices compare with others



Cities 4.0 enjoy greater autonomy from national and state control

(% citing significant or full autonomy)



Q11: What steps will your city focus on over the next three years to enhance the use of ecosystems of suppliers and partners to meet your social, environmental, and economic goals? Q28: When pursuing its urban goals, how much autonomy from national/state/provincial control does your city have in the following areas?

Cities 4.0 ensure that citizens are engaged and digitally connected

Cities 4.0 understand that their sustainability and smart city programs will fail without the backing of citizens.

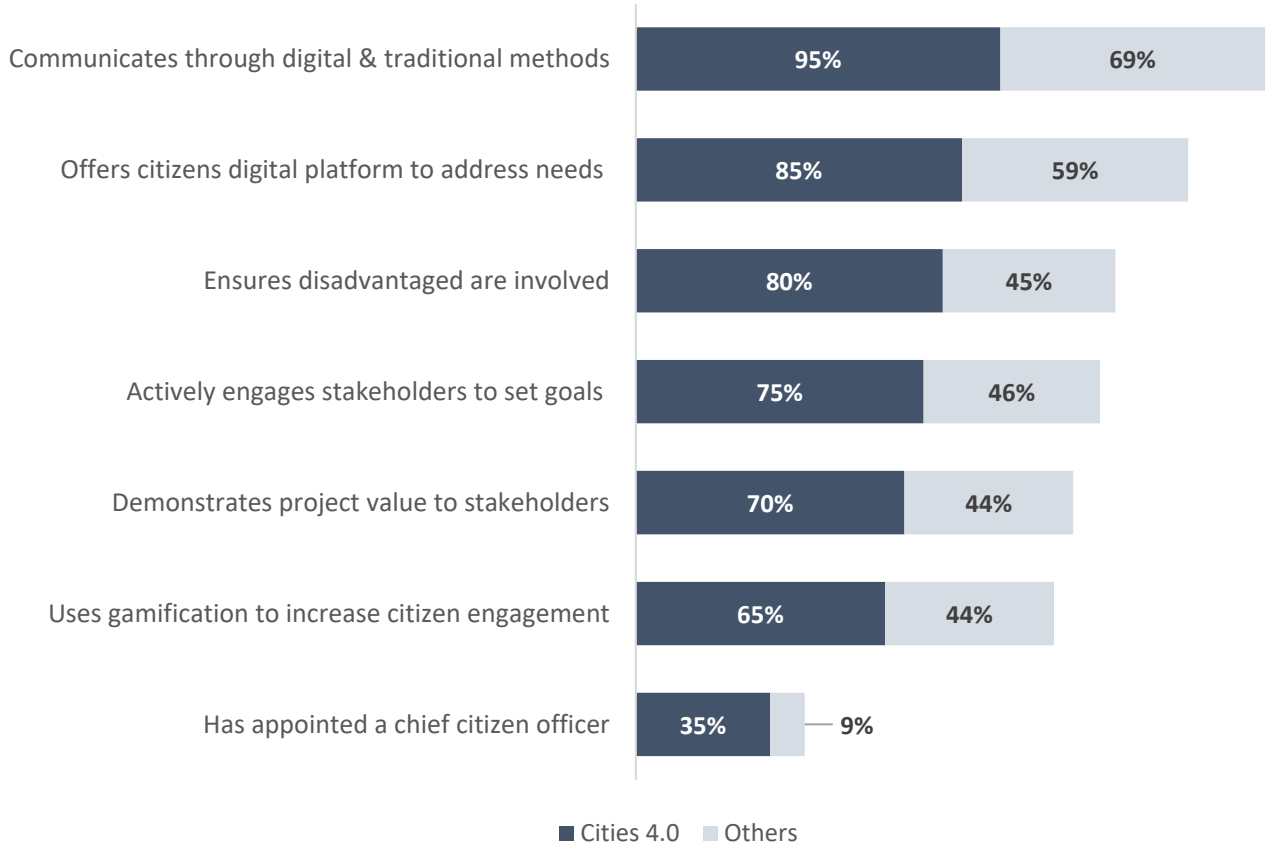
Cities 4.0 are highly sensitive to the needs of their citizens and use a combination of digital and traditional methods to communicate with them. They actively engage citizens, communities, and other stakeholders when setting goals, demonstrate the value of projects, and ensure that disadvantaged populations, including the poor and handicapped, are involved in the decision-making process.

Stealing a page from private businesses, more than a third of Cities 4.0 have appointed a Chief Citizen Experience Officer to stay connected to citizens. The CCXO is responsible for the end-to-end experience of citizens, ensuring that city websites, call centers, and mobile apps are designed with citizens' needs and ease of use in mind.

"We're making a big investment in addressing the digital divide. One area is supplying a hot spot and tablet checkout program. We have 19 neighborhood and community centers where residents can access high-speed broadband internet and pick up a tablet, which connects them with services in the community and supports them with financial literacy."

Chris Castro, Director of Sustainability and Resilience, Orlando

How cities foster citizen engagement



Q29: Which steps does your city take to foster citizen engagement?

The ROI of being a 4.0 City

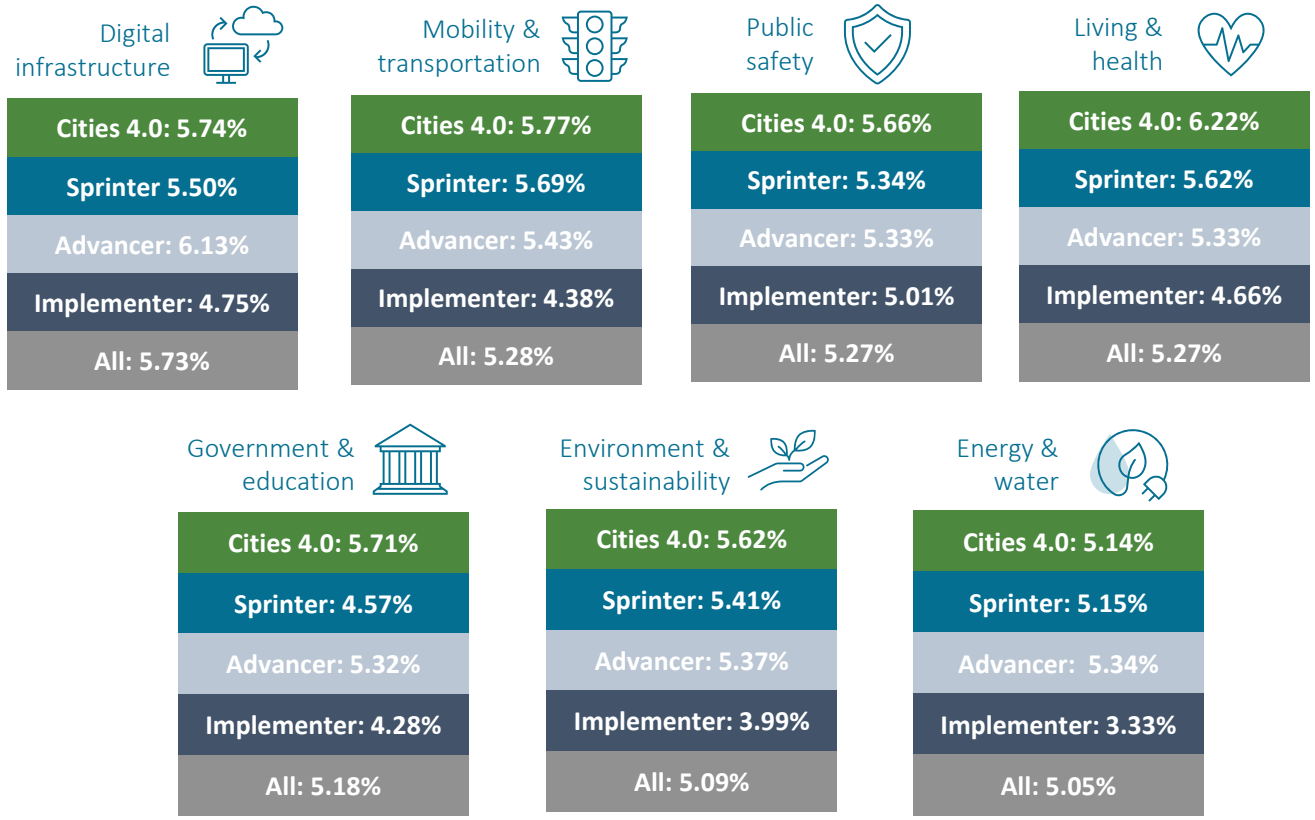
We asked city leaders to estimate the ROI achieved from their technology investments across urban domains.

Based on reported ROI estimates, the average return on investments made by Cities 4.0 across urban domains ranges from 5.14% to 6.22%. Investments in living and health drive the greatest returns for Cities 4.0, followed by mobility and transportation, and digital infrastructure.

These percentages likely represent lower-bound ROI estimates, since many of the social, health, environmental, and business benefits are difficult to quantify. Such qualitative benefits include creating new business opportunities, filling talent gaps, improving public health, reducing crime, boosting productivity, and addressing income inequality. In addition, the payback period can be long on these projects, with bigger returns coming from wider deployment.

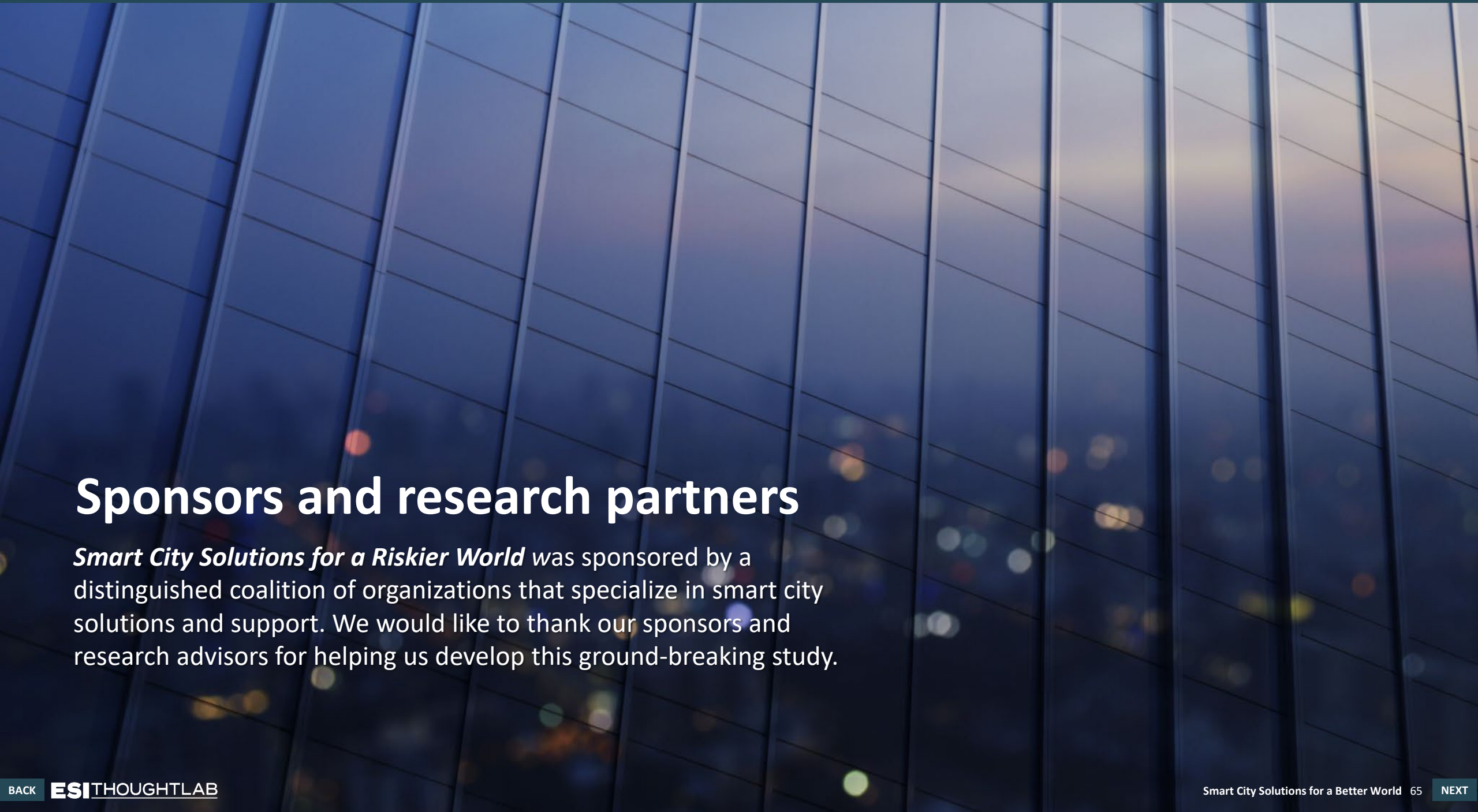
> "You don't need a lot of money to have impact. You can be creative, and the value doesn't always have to be financial for everybody. Our value-add when we partner is to provide some of the funds, but we also provide the capacity and absorb the risk. And I always keep focused on the economics, the environmental impacts, and the social impacts. Those are what really drive the selection of projects."
>
> **Emily Yates, Smart City Director, Philadelphia**

Average ROI by urban domain



ROI methodology: As part of the survey, we asked city leaders to estimate the ROI achieved from the technology investments deployed in their cities. These estimates were self-reported, order-of-magnitude returns on different investments. For each city, we calculated the average ROI for each domain.

Q32: In which of the following technology solutions are you making large investments, what ROI are you seeing, and how long has the project been in place?



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