ESI THOUGHTLAB

A leader in evidence-based research

Smarter Cities 2025

Building a sustainable business and financing plan

A thought leadership white paper

November 2018

1. Introduction

The convergence of digitization, globalization, and demographic change is redefining the urban landscape and how people shop, work, travel, and live. It is also causing businesses to adopt new innovative strategies solutions to meet the new realities of urban life and digital commerce. To stay relevant, cities need a fresh way of thinking.

In today's digital age, becoming a smart city is vital for attracting business, residents, tourists, and talent, and for ultimately fostering growth and prosperity. Cities that undergo smart transformation unlock benefits that can be then reinvested into additional developments, creating a virtuous cycle of economic growth.

But the path to a smart city future is often unclear to urban leaders; many are looking for a roadmap to drive the best results. To provide direction, ESI ThoughtLab teamed up with a coalition of organizations with urban and technology expertise to conduct ground-breaking research into the impact of smart city solutions on urban performance. Our analysis enabled us to

answer three crucial questions:

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

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

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

The future success of cities will depend on their ability to become smart cities. By drawing on the latest technology and capitalizing on data analytics, they will be better equipped to solve urban problems, provide high-quality services, and drive sustainable growth. This white paper provides an overview of the smart city practices and performance results in cities around the world.

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

Research approach

ESI ThoughtLab conducted an in-depth benchmarking survey of government leaders in 136 cities around the world to understand their smart city perspectives, practices, and performance results. To gain insight into the views of city stakeholders, we also conducted surveys of 750 business leaders and 2,000 residents in 11 "proxy" cities with varying levels of economic development, social and geographic diversity, and technology use. These surveys helped us to understand how well-aligned these different stakeholders are in the ways they think about smart cities.

Figure 1.

We then correlated the statistical input from the surveys with data from respected secondary sources to create micro- and macro-economic models to quantify direct, indirect, and catalytic benefits of smart city investments in the 11 proxy cities, which could be extrapolated to cities with similar characteristics.

Throughout the research process, our distinguished advisory board of business and academic leaders provided valuable input on smart city practices and their impacts. Please see the full list of advisors in the appendix at the end of the white paper.

Defining smart city maturity

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

1. Level of smart city investments
2. Use of data analytics
3. Application of smart technologies
4. Self-rating on stage of smart city maturity

We arrived at an overall maturity score by combining the normalized scores for each of the 10 pillars; the latter scores were based on the priority that respondents gave to each pillar (ranging from 0, no priority, to 5, high priority). Based on the overall derived maturity score, we stratified the cities into three categories: **beginner**, **transitioning**, and **leader** (Figure 4). Beginners had scores below 1.66; transitioning from 1.67 to 3.05; and leaders averaged above 3.05. These categories helped us to identify the 11 proxy cities (Figure 5) across the maturity continuum that we used for our deep-dive analysis.

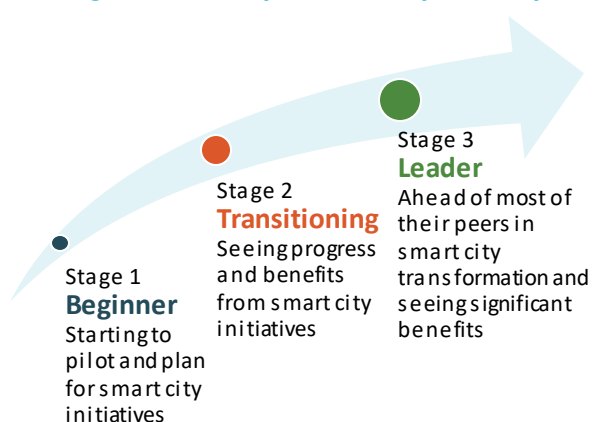Figure 2. **Journey to smart city maturity**

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

Stage 2
Transitioning
Seeing progress and benefits from smart city initiatives

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

Figure 3. **Across 10 pillars of smart city success**

Foundational

- Governance
- Economy
- Infrastructure
- Talent
- Funding

Tech-enabled

- Mobility
- Environment
- Public Safety
- Public Health
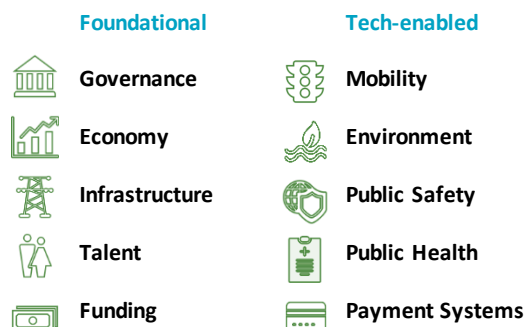- Payment Systems

Figure 4. **Cities by maturity classification**

Beginner

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

Transitioning

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

Leader

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

Figure 5. **Proxy cities**

2. The Business Case for Smart Cities

Our modeling and analysis found that as cities advance their smart city transformation, they are better able to reap the benefits of investments in new technologies and systems. With sound governance, adequate funding, and talented workers, smarter cities can capitalize on investments in innovation to generate new revenue streams and cost efficiencies. At the same time, smarter cities increase economic activity and livability for citizens and businesses.

Currently, cities see livability improvements as the main initial benefits from smart city investments. But in three years, they expect economic and financial benefits to grow materially as the virtuous cycle gains momentum (Figure 6).
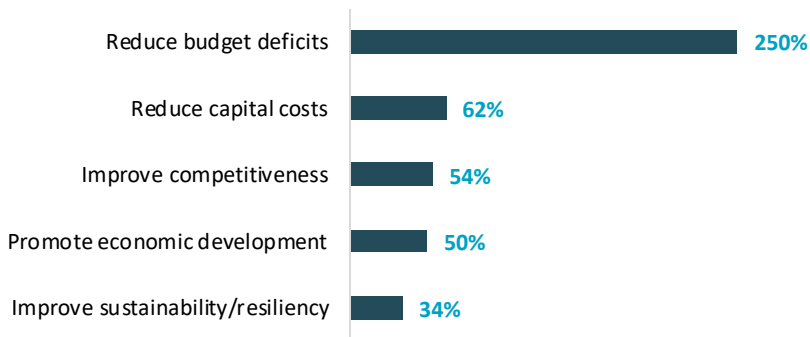
"Cities strive to innovate but funding these initiatives—when ROI has been uncertain—has been challenging. Advanced technologies are the path, and cities need to develop a framework that will help them identify how to prioritize and measure their modernization efforts."
- Susan O'Connor, Global Director, Public Sector Industry Marketing, Oracle

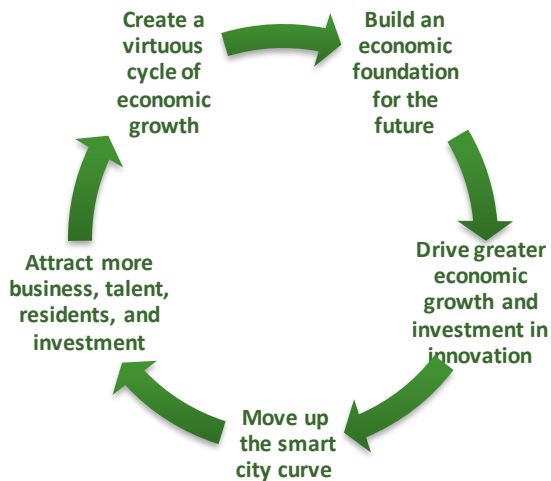| Table 1. **Top benefits realized now and expected by 2021**	
Now	**Three years**
1. Ensure safety and security	**1. Generate additional revenue**
2. Improve infrastructure	2. Improve infrastructure
3. Generate additional revenue	3. Ensure safety and security
4. Ability to adapt and innovate	4. Ability to adapt and innovate
5. Attract residents and tourists	5. Citizen satisfaction with services

Figure 6. **Fastest growing expected benefits**

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

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

Our research reveals that smart investments trigger a virtuous cycle of economic growth by generating capital for new smart city investments and attracting businesses, residents, tourists, students, and talent (Figure 7). Over the longer term, successful cities will morph into digitally-enabled hotbeds of innovation that will be a magnet for future talent, drive performance, and improve the human condition. Those cities that fail to keep up with smart innovation risk falling even further behind the competition for capital, talent, and economic growth.

The ROI on the 10 pillars varies by smart city maturity

Leaders realize greater returns on investments across most smart city pillars. For example, about 24% have an ROI of over 7% on investments in environment, 18% have an ROI over 7% on mobility, and 12% have an ROI over 7% on public health (Figure 8).

Beginner and transitioning cities are more likely than leaders to see returns of over 7% on their investments in infrastructure and governance. None of the beginners surveyed generate an ROI over 7% on public health, economy, talent, and funding--which reflects their lower commitment to these pillars.

Figure 7. **The virtuous cycle of economic growth**

Figure 8. **The ROI on investments in smart city pillars by maturity stage**

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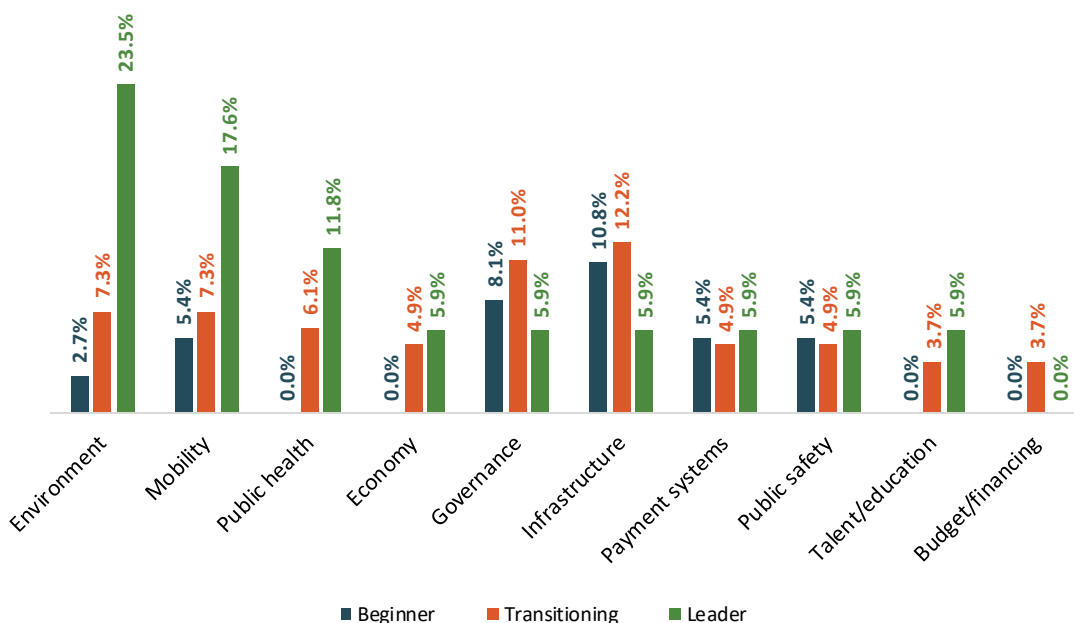
Q: What level of return has your city realized on its smart city investments? (% citing large positive >7%)

Our survey shows that most cities expect to increase their smart city maturity over the next three years. The biggest jump will be from beginner cities, which will go from an average maturity score of 1.2 to 1.8, moving the average beginner into the transitioning stage (Figure 9). Since the resulting smart city benefits from smart innovation will make cities more attractive places for residents, workers, and businesses, this should lead to additional economic growth as part of the virtuous cycle.

Our economic analysis found that on average the catalytic impacts associated with becoming a smarter city can potentially increase GDP per capita by up to 21% and population growth by 13% (Figure 10) over five years in beginner cities, if they achieve their stated smart city plans. Transitioning and leader cities can potentially see additional GDP per capita and population increases as well, albeit at a slower rate.
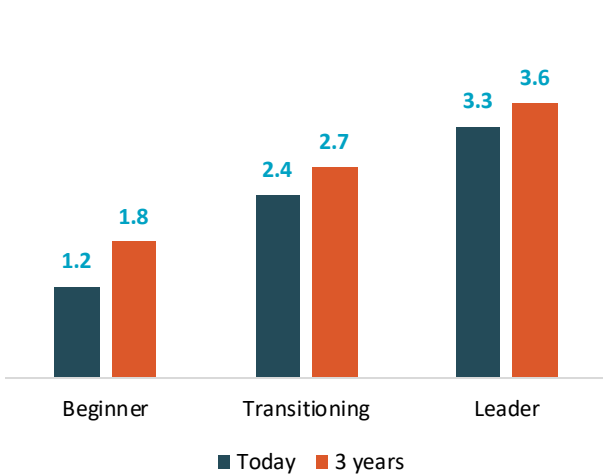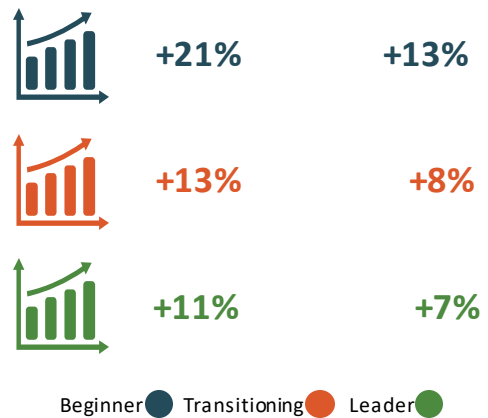
Figure 9. **Where will cities be in 3 years?**

Figure 10. **Beginner cities will see the largest growth in GDP and population**

	GDP per capita	Population
Beginner	+21%	+13%
Transitioning	+13%	+8%
Leader	+11%	+7%

Beginner ●   Transitioning ●   Leader ●

Figure 9 data:
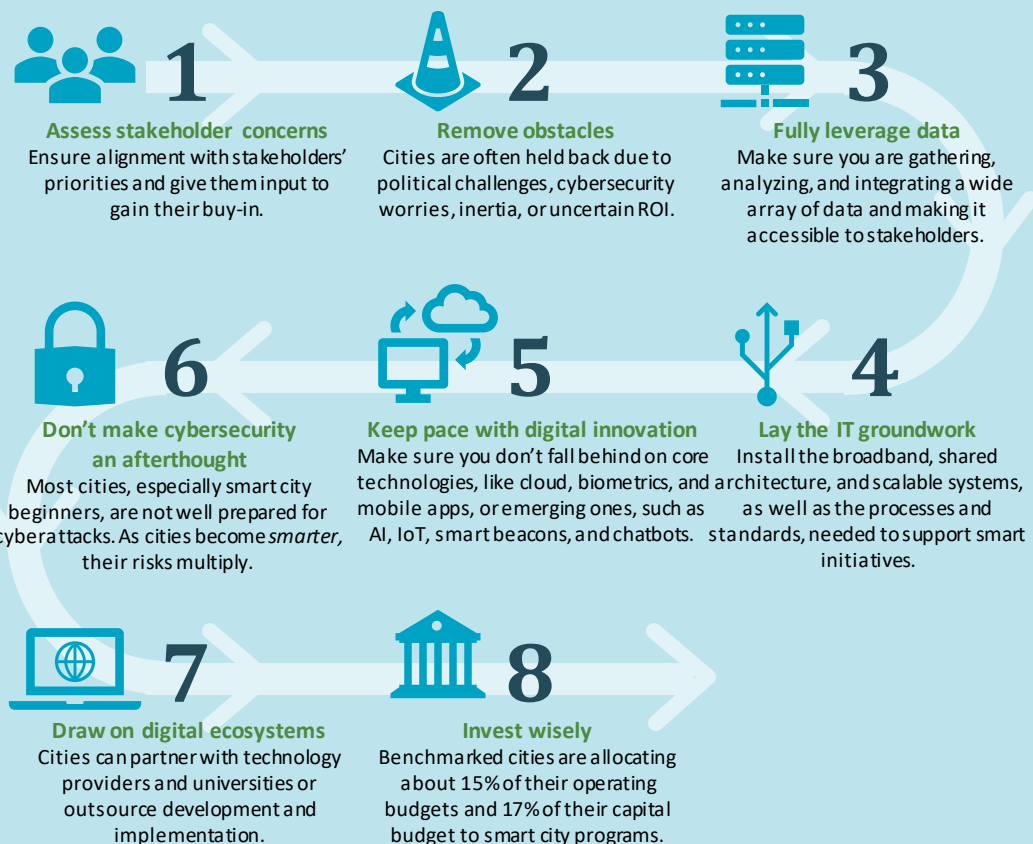|	Today	3 years
Beginner	1.2	1.8
Transitioning	2.4	2.7
Leader	3.3	3.6

■ Today ■ 3 years

3. The Path to a Smart Future

By making their cities smarter—not just in using technology but in all that they do—government leaders hope to garner many economic and catalytic benefits, driving competitiveness and growth, while making massive social, business and environmental improvements. But without a clear playbook, cities run the risk of falling behind peers.

The path will vary by city, depending on the issues it faces. The key challenge for urban leaders is to incorporate the concerns of their stakeholders and the use of fast-changing digital technologies into a properly staged roadmap that will lead to the best results. Figure 11 outlines the key steps that our research found should be part of that roadmap.

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

Figure 11. **Roadmap for smarter cities**

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

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

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

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

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

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

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

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

Incorporating stakeholder priorities into your roadmap

A key to building a clear roadmap for smart city transformation is fully understanding common priorities and concerns--and key differences--among urban stakeholders. While businesses and citizens have different perspectives on the problems facing cities, our research, as shown in Table 2, found that climate change and mobility/congestion were among the top priorities for most stakeholders. In general, they have high expectations for future development of mobility and environmental applications. Our survey found that both citizens and businesses are willing to pay more to for those investments.

When starting their smart journeys, cities often face obstacles, including inertia and political, union, and cultural challenges. As cities mature, cybersecurity, departmental coordination, and operational disruption rise as worries. While some of these obstacles remain for leaders, concerns over legacy systems and inclusivity grow. Uncertain ROI is a hurdle for all cities, regardless of maturity.

Table 2. **How the priorities of stakeholders compare**

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

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

Building the IT and data infrastructure

Most smart city technologies run on sensors and other connected assets that are linked together through wireless and broadband networks. Few beginner cities have the IT infrastructure in place to support effective smart city transformation. They lack the broadband systems, digital transformation processes, shared, scalable architecture, and other elements needed to facilitate smart development. Few beginner cities are doing even basic data tasks, such as collecting, extracting, integrating, and analyzing data.

Transitioning cities are far more advanced in their use of data compared with beginner cities. Even so, they are still at only half the level of the leaders. Since many smart solutions are dependent on data, it is vital for cities to make data management an area of excellence. This includes making data accessible to stakeholders and monetizing its value.

Cities identified as smart city leaders are now far ahead of others in the use of emerging sources of data, such as IoT, real-time, AI, predictive, and geospatial data. By 2021, most leaders will use these more sophisticated forms of data. Over the next three years, however, cities across smart city maturity levels plan to rachet up their use of a wider variety of data (Table 3), and beginners and transitioning cities hope to catch up to the leaders in their use of data and emerging technologies.

By 2021, almost all cities will draw on IoT and real-time data. Geospatial, administrative, behavioral, predictive, and social media data will become commonplace. The use of AI-generated data will grow fourfold. Predictive data, which is already used by about 40% of cities, will rise in usage by 63%. Similarly, both geospatial and behavioral data will rise by 54%.

Laying the IT groundwork is crucial for smart cities, since most smart technologies run on sensors and other connected assets that are linked together through wireless and broadband networks. Beginner cities will need to start to put in place the IT infrastructure required to support effective smart city transformation. This includes the broadband systems, digital transformation processes, shared architecture, scalable systems, and other elements needed to move up the smart city maturity curve.

Keeping pace with digital innovation

With Silicon Valley setting the pace, digital innovation are progressing faster than many cities can react. However, cities that fail to adopt these technologies now may become less competitive and attractive to businesses and consumers in an increasingly digital marketplace.

Table 3. **Cities plan to leverage a wide array of data**

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

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

### Table 4. **Technologies cities use now and plan to use**

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

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

Cloud-based technology, mobile apps, citywide data platforms, IoT/sensors, biometrics recognition, and geospatial technology are now used by more than half of the 136 cities in our survey (Table 4). By 2021, these technologies will be more commonplace for urban centers, used by three-quarters and more. While blockchain, drones, augmented and virtual reality (AR/VR), artificial intelligence, and Vehicles to Everything (V2X) are now used by just 1 out of 10 cities, or less, these technologies will be skyrocketing in urban use over the next three years. Blockchain will grow by 752% in use; AI, +526%; Drones/robots, +298%; Vehicles to Everything (V2X), +257%; VR/AR, +254%; and chatbots, +173%.

To accelerate digital transformation, cities rely both on internal teams and external ecosystems of suppliers and partners. Over half of leaders outsource implementation to consultants, partnering with technology providers, and licensing or buying the technology. Transitioning cities are more likely to partner with academic institutions or service providers than to outsource implementation to consultants, while beginners are more apt to partner with service and technology providers, and license rather than buy the technology. Across all maturity levels, cities are investing the most in mobility, environment, governance, and infrastructure (Figure 12).

Figure 12. **How smart city leaders are investing in technology across the 10 pillars**
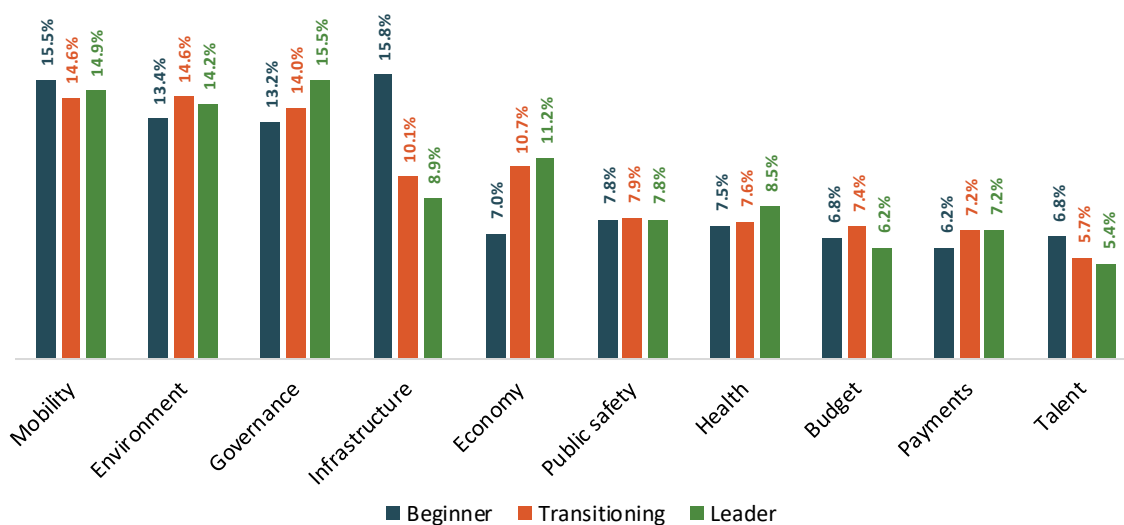
Q: How are your smart city investments distributed across the following areas?

For some pillars (mobility environment, governance, economy, payments), the level of investment increases as cities become more mature, while in others the level of investment decreases (infrastructure, public safety, talent). Beginner cities invest the most in infrastructure and mobility, while leaders spend the most on governance.

Cities that are embracing digital innovation may not be paying enough attention to cybersecurity. Our survey reveals that only about a third of cities is well prepared for cyberattacks. The majority are only slightly or moderately prepared. Beginner cities are particularly vulnerable. None of them said they were well prepared for cyberattacks and almost three-quarters described themselves as only slightly prepared.

3. The 10 Pillars of Smart City Success

Our research identified 10 smart city pillars (Figure 13) that work together to drive benefits to stakeholders. While urban leaders will vary in their approaches based on the issues their cities face, successful cities create roadmaps based on the foundational and tech-enabled pillars.

Five foundational pillars—**governance, economy, infrastructure, talent, and funding**—underpin a successful smart city. Without the right vision, plans, and resources in place, smart city programs will not reach their full potential.

In addition to the foundational pillars, urban leaders should focus on five tech-enabled pillars—**mobility, environment, public safety, public health, and payment systems**—that will drive value to all urban stakeholders. While no two cities are the same, there are many urban issues that can be addressed through digitally enabling these five pillars.

Except for smart infrastructure, leaders give higher priorities to every smart city pillar than do less mature cities. Beginners placed a lower priority on foundational pillars such as talent, payments, or funding, which may undermine their future success (Figure 14).

Laying the foundation

Smart governance is key for building a smart city. Step one is creating a tech-enabled vision, with a cohesive implementation plan to deliver results in a cost-effective way. To be successful, urban leaders must factor in the expectations of local citizens and businesses to ensure alignment and buy in. Setting a policy framework that encourages innovation and adoption of smart technologies is vital for driving performance. Unfortunately, our study shows that stakeholders believe their city leaders often do not focus enough on governance, particularly at the start of their smart city journey, when it is most needed.

Figure 13. **The 10 pillars of smart city transformation**

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

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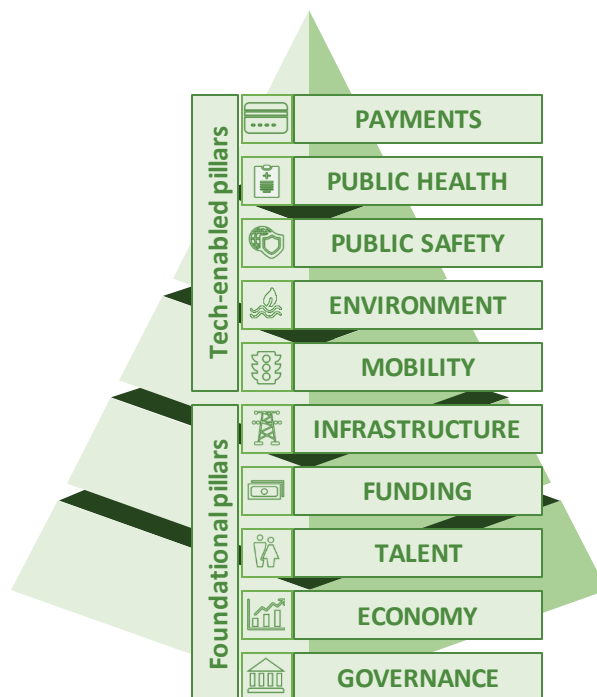
"Given the accelerating urbanization occurring globally, infrastructure is one of the most important critical elements to sustainable communities. The implementation of smart solutions will ensure that the optimization of the investments made will have an enduring impact on health, safety and economic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

Figure 14. **Smart pillar priority by level of maturity**
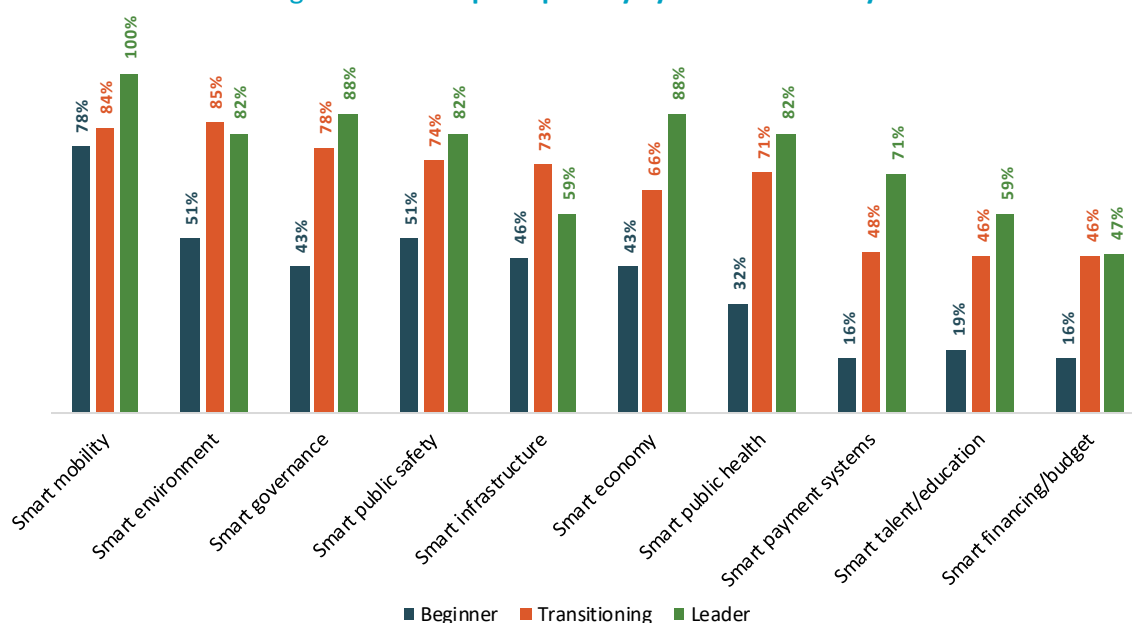
Q: What level of priority does your city place on each of the following smart city dimensions?

Smart economy. A cogent economic development plan for future smart city growth requires building an economic environment that attracts business and investment, fosters industry development, promotes e-commerce, and creates local and global trade linkages. With digital technology, industrial sectors, global linkages, and customer behaviors in a state of flux, cities need to replace old economic models built on single industries or skill sets that are no longer relevant. They must ensure they have an economic foundation in place that will allow their cities to succeed in today's fourth industrial revolution.

Smart infrastructure. Connected—and well maintained—buildings, roads, electricity, sewerage, telecommunications, and water systems are crucial building blocks for smart city development. Yet the path to expanded digital connectivity can vary city by city. Early adopters need to replace legacy systems with new technologies, while some late-comers to the digital revolution can leap-frog to mobile solutions. In addition to upgrading their digital capacity, beginners often face a challenge in ensuring that their cities meet basic requirements of reliable electricity, clean water and streets—keys to retaining citizens.

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

Smart funding. Financing the smart solutions needed to meet the demands of growing populations is a challenge for many cities. To invest in these smarter technologies and services, cities will need to be more innovative in their funding techniques, sources of capital—including private-sector partnerships—budget approaches, and business models. Unfortunately, smart funding is one of the most overlooked pillars for cities starting their smart city journey. But without proper funding a smart city program cannot succeed.

Becoming smarter: technology-enabled pillars

Smart mobility. Our study shows that the future of mobility is multi-modal—involving a wide array of fully integrated and connected options, including public and private services, across all modes of transportation. Smart cities are developing choices to meet the needs of residents from across generations, including ride-sharing, bike- and car-sharing, smart transit systems, real-time transit mobile apps, smart traffic signals and smart parking.

Smart environment. Improving environmental sustainability, energy use, and resource allocation through innovative solutions is their number one challenge, according to our survey of 136 government leaders. Climate change, a related issue, was ranked third. However, climate change becomes a higher priority for cities as they mature and work through more basic environmental and energy management issues.

Smart public safety. Some 45% of 136 cities surveyed see high crime rates and improving public safety as an important challenge that they hope to tackle using smart technologies. Concern about crime is even more pronounced in Asian cities (68%) and in large cities with populations over 10 million (53%). Technologies they are exploring include big data and AI, predictive policing, drones, acoustic sensors, body cameras, and smart street signals and sensors.

Smart public health. While public health is often considered a national or private-sector issue, city governments have a responsibility to promote and ensure a healthy living environment. Smart cities are working with healthcare providers to promote the use of latest technologies, such as wearable sensors that monitor an individual's physical activity and health, telemedicine that allows doctors to treat patients remotely, and street sensors that track air quality and pollution.

Smart payment systems. Digital payment systems—including debit/credit cards, electronic bill payment and mobile apps—eliminate the need for cash, enabling stakeholders to maximize the value from smart city solutions. More intensive use of smart payments will help business reduce costs and can have significant benefits for government, improving transparency for stakeholders and enabling government to strengthen financial controls, minimize fraud, and increase revenue.

5. Performance Impacts of Smart City Transformation

ESI ThoughtLab economists created rigorous performance impact models for five key pillars of smart city development: mobility, environment, public safety, public health, and payment systems. The economic models draw on the following data: (1) Secondary data on the impacts of types of smart city investments. (2) City-specific data on smart city practices from the government survey. (3) City-level profile data (e.g. on population, income, transit ridership). (4) Primary data from the business and consumer surveys.

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

By measuring the direct, indirect, and catalytic benefits of smart city programs, our models allow us to estimate the impacts from becoming a smart city leader. By benchmarking cities according to their stages of smart city maturity, our economists extrapolated the potential performance impact for other cities in similar stages of development.
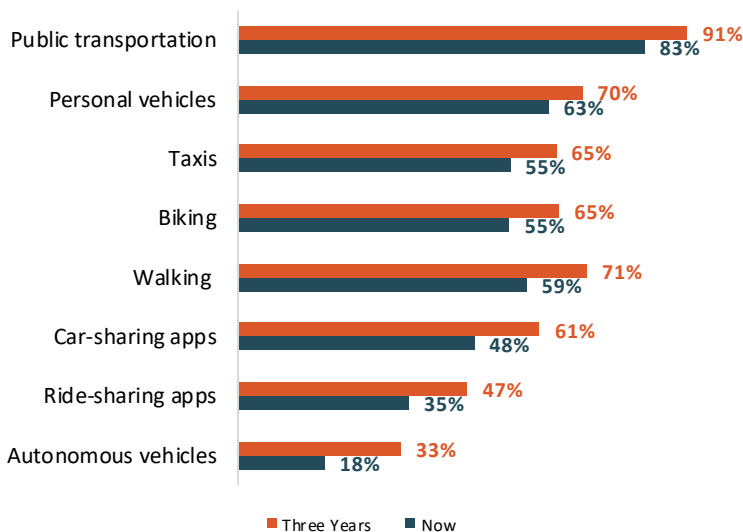
Figure 15. **Smart city models**

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

Figure 16. **The importance of transport modes now and in three years**

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

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

Mobility: Cutting congestion and pollution through smart traffic signals

Our study revealed that cities are developing multiple modes of transportation to provide greater efficiencies for residents and businesses (Figure 16). At the same time, leaders in traffic management use innovative technologies like smart traffic signals, sensors, predicative analytics, and cashless tolling to reduce congestion. ESI ThoughtLab economists estimated the benefits to cities of increased usage of smart traffic signals and mobile apps for transit information.

A study by Carnegie Mellon University found that smart traffic signals could reduce overall travel time up to 25%, creating benefits not only reserved for those commuting, but for the city as a whole. In addition to saving time, fuel, and frustration for drivers, congestion reduction can cut pollution, increase productivity, and increase citizen satisfaction. Cities that have not yet implemented smart traffic signals can potentially gain the largest per capita time savings. Potential savings is lower for more mature cities, which have already made progress on smart traffic signals.

Figure 17. **Total per capita personal time savings, in hours, from traffic reduction**
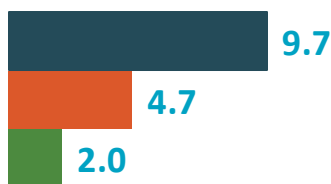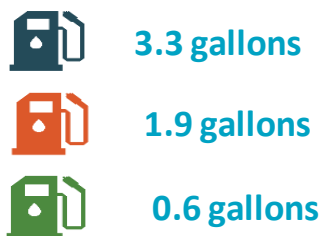
9.7
4.7
2.0

Figure 18. **Average annual per capita fuel savings**

3.3 gallons
1.9 gallons
0.6 gallons

Traffic management maturity stage: Beginner ● Transitioning ● Leader ●

Researchers from the City College of New York and Georgia Institute of Technology found that, in addition to decreasing actual and perceived waiting time, transit mobile applications can also increase ridership. Drawing on that academic research and our survey results, ESI ThoughtLab estimated that a transit mobile application can increase ridership by an average of 6.92 trips per capita per year for beginning cities (Figure 19). More mature cities that already use some form of this technology can capture additional benefits through improvements in usage, accuracy, and functionality.

Figure 19. **Increased ridership: annual trips per capita per year**

6.92
4.83
3.95

Figure 20. **Time savings: travel hours saved per capita per year**

10.03
7.01
5.72
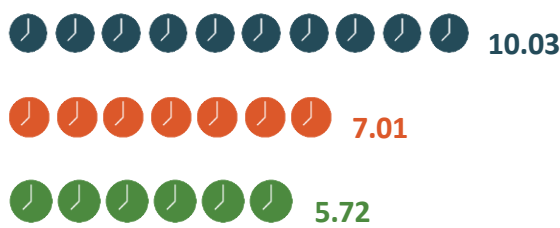
Public transportation maturity stage: Beginner ● Transitioning ● Leader ●

Environment: Performance improvements from smart grids

The environment and climate change are two of the top urban challenges that cities hope to correct through smart technologies. ESI ThoughtLab modeled the impact of smart grid technology adoption in cities in terms of dollars of energy savings and CO2 emissions reductions. Integrated volt control capabilities from smart utility grids can help manage voltage on their distribution lines, allowing utilities to reduce the total energy used by citizens without sacrificing service or quality. A study by the Smart Grid Consumer Collaborative found that this technology can reduce voltage needed during peak demand hours by 3.25%, resulting in an overall total electricity reduction of 2.7% on average per year. Factoring these results into our models, ESI ThoughtLab estimates that cities in the beginning stages of smart energy maturity could realize usage reduction per capita of $29.86 p.a. and a reduction in CO2 emissions of 223 pounds per person per year (Figures 21 and 22).

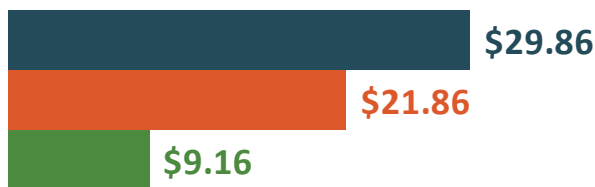Figure 21. **Total per capita energy savings by smart energy maturity level**

$29.86
$21.86
$9.16

Energy management maturity stage: Beginner ● Transitioning ● Leader ●

Figure 22. **CO2 emissions reduction per capita by maturity level**

223 lbs.
166 lbs.
70 lbs.

Public safety: Reducing crime through predictive policing

Reducing crime helps cities reduce the direct costs of both violent and property crime to victims and they expense they bear for preventive measures. ESI ThoughtLab economists modeled the benefits cities could realize by adopting predictive policing. A recent study by researchers at UCLA found that predictive policing reduces violent crimes by about 5% and property crimes by about 10%. On average, this reduction in crimes leads to a savings of $420.33 per capita across our 136 cities. Cities starting to embrace smart crime technologies will realize larger benefits than those cities that are more advanced. We estimate that beginner cities could cut crime costs by $529.60 per capita; this includes costs to the victim, pain and suffering, and costs to the criminal justice system (Figure 23).

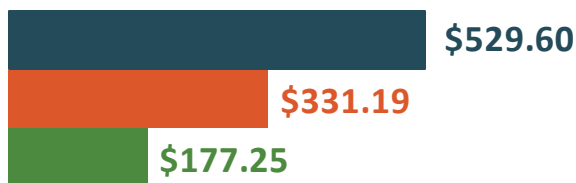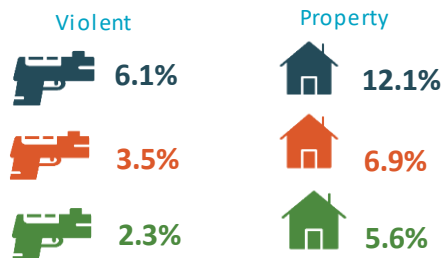Figure 23. **Total per capita crime reduction savings by smart crime maturity level**

$529.60
$331.19
$177.25

Crime technologies maturity stage: Beginner ● Transitioning ● Leader ●

Figure 24. **Total crime reduction**

Violent | Property
6.1% | 12.1%
3.5% | 6.9%
2.3% | 5.6%

Public health: The impact of telemedicine on chronic disease

Many countries are embracing telemedicine to manage chronic, non-infectious diseases such as chronic obstructive pulmonary disease (COPD), which is expected to be the world's third leading cause of death by 2030. Remote medicine allows patients to manage their care at home, without physically visiting their doctors, and practitioners are more easily able to monitor their patients' symptoms.

A recent study prepared for the auditor general for Scotland found that using telemedicine for citizens with moderate to severe COPD can reduce costs by approximately 21%. We estimate that the adoption of telemedicine for COPD patients would result in an average cost savings of $23.83 per capita in cities not currently using any type of telemedicine (Figure 25); cities already using telemedicine to some extent can still capture additional benefits through expansion and improvements.

Figure 25. **Per capita healthcare savings from treating COPD through telemedicine**

$23.83

$15.74

$7.19

Health technologies maturity stage: Beginner ● Transitioning ● Leader ●
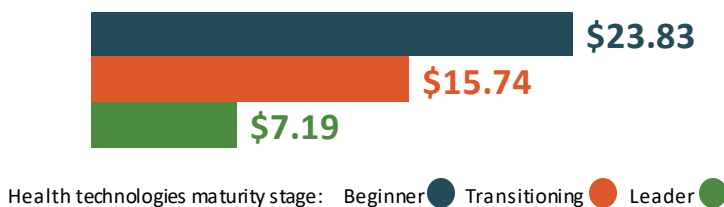
Payments: Cost efficiencies from going digital

Businesses across cities expect customers to expand their use of digital payments, including debit cards, credit cards, mobile payments, and wire transfers, while decreasing their use of physical money. The largest drops in cash usage will be in leader cities, but the growth of digital payment methods will happen across smart city stages. ESI ThoughtLab economists modeled the cost savings that cities would realize from adopting smart payments through payment efficiencies and reductions in the shadow economy.

According to our survey, nearly a third of cities are in the beginning stages of using smarter payments and another 43% are in the transitioning phase of using smarter payments. Our economic analysis, as shown in Figures 26-27, found that cities in the beginning stages of smarter payment usage can see cost savings of 0.17% of GDP, or $144 per citizen; transitioning cities can unlock savings of 0.12% of GDP, or $140 per citizen; and leader cities can realize additional cost savings of 0.09% of GDP, or $126 per citizen.
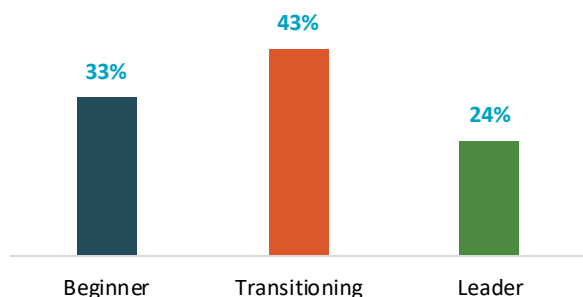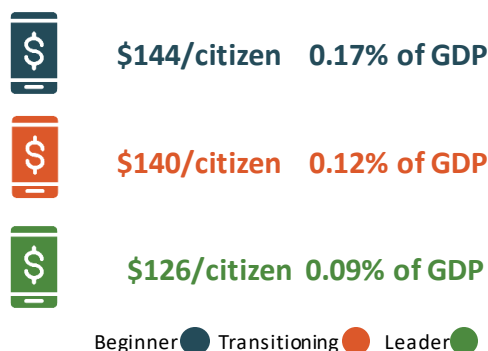
Figure 26. **Smart payment maturity**

33%

43%

24%

Beginner   Transitioning   Leader

Figure 27. **Average payment efficiency cost savings by maturity**

$144/citizen   0.17% of GDP

$140/citizen   0.12% of GDP

$126/citizen   0.09% of GDP

Beginner ● Transitioning ● Leader ●

In addition to cost savings, digital payment systems reduce the size of the shadow economy. The shadow economy is comprised of two main components—underground purchases that are undertaken to avoid taxation and illegal activities, such as drug dealing, prostitution, and corruption. We estimate that in smart payment beginner cities, the average size of the shadow economy is 25% of GDP, in transitioning cities it is 13% of GDP, and in smart payment leader cities it is 10% of GDP (Figure 28).

Our economic analysis, as shown in Figure 29, found that increases in smart payment maturity in beginner cities can reduce the size of shadow economy by an average of $5.3 billion per city, which is equal to 5.6% of GDP. In transitioning cities, the average reduction is $2.9 billion per city (1.7% of GDP), and in leader cities, the average reduction is $2.6 billion per city (0.9% of GDP).

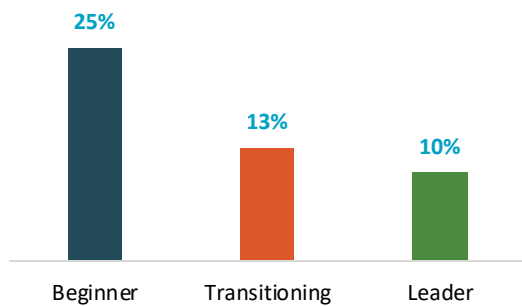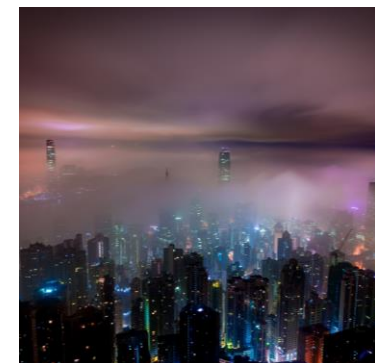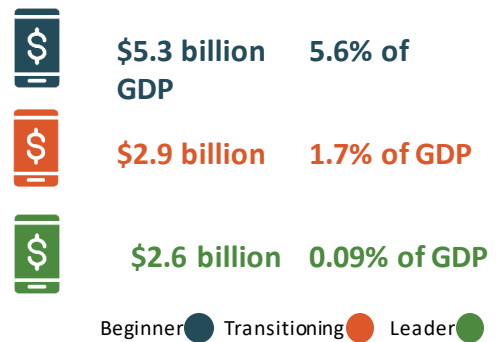Figure 28. **Shadow economy as percent of GDP**

25%	13%	10%
Beginner	Transitioning	Leader

Figure 29. **Average shadow economy reduction by maturity**

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

Beginner ⬤ Transitioning ⬤ Leader ⬤

6. Calls to Action: 10 Insights from our Research

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

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

3. **Put in place the needed infrastructure.** "In the age of the smart city, 'architecture' doesn't just mean physical buildings anymore—it means the 'technology architecture' that will tie together and optimize the myriad different 'smart' initiatives cities will need to make to stay attractive to new waves of citizens," according to Ben Pring of Cognizant. "Cities of the future will have 'operating systems' that tie the physical and digital together." To accomplish this, cities will need fast and reliable fixed and mobile broadband, public WiFi, citywide data platforms, and shared and scalable IT architecture, as well

as the processes and standards to support smart initiatives. Avoid making cybersecurity an afterthought by incorporating it in every step of your digital transformation plan.

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

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

6. Calls to Action: 10 Insights from our Research

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

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

8. **Invest in your city's multi-modal future.** With populations growing and congestion increasing, cities will need to diversify modes of transportation to include ride-sharing, car-sharing, bike-sharing, and other innovative approaches. At the same time, smart cities must continue to maintain the efficiency and reliability of public transportation to ensure it stays competitive with private-sector mobility options.

Smart use of data, apps, road sensors, and other digital solutions can boost the performance of traditional transit modes and raise ridership and revenue. "Mobility is a significant opportunity for city governments," says Mark Saunders of Ferrovial, "because it benefits multiple factors, including time savings and emissions improvements, as well as giving a boost to the local economy."

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

10. **Follow the leaders**. Cities should take inspiration from how leaders approach their smart city investments—starting with a roadmap and first getting the foundations in order, including a sound governance structure, sufficient financing, and incentives to attract talented workers. After getting their foundations in place, transitioning and leader cities can realize more significant returns through investments in environment, mobility, and public health. They can then tap into the virtuous cycle of economic growth to bring their city to new heights.

Appendix: Smarter Cities 2025 Advisory Board

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About ESI ThoughtLab

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

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

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